Naming is framing:

The public understanding of scientific names

Reginald Boersma

Naming is framing:

The public understanding of scientific names

Reginald Boersma

Thesis committee

Promotor
Prof. Dr B. Gremmen
Personal chair at the Philosophy Group
Wageningen University & Research

Co-promotor
Dr P.M. Poortvliet
Assistant Professor, Strategic Communication Group
Wageningen University & Research

Other members
Prof. Dr H. Zwart, Radboud University, Nijmegen
Prof. Dr R.D. Hall, Wageningen University & Research
Dr J.M. Gutteling, University of Twente
Dr F. Kupper, VU Amsterdam

This research was conducted under the auspices of the Wageningen School of Social Sciences (WASS)

Naming is framing:

The public understanding of scientific names

Reginald Boersma

Thesis

submitted in fulfilment of the requirements for the decree of doctor
at Wageningen University
by the authority of the Rector Magnificus
Prof. Dr A.P.J. Mol
in the presence of the
Thesis Committee appointed by the Academic Board
to be defended in public
on Monday 4 June 2018
at 4 p.m. in the Aula.

Reginald Boersma
Naming is framing: The public understanding of scientific names,
195 pages

PhD thesis, Wageningen University, Wageningen, NL (2018)
With references, with summaries in English and Dutch

ISBN 978-94-6343-294-8
DOI https://doi.org/10.18174/449786

Table of contents

General Introduction 8

Introduction 9

Names influencing perceptions: An overview 13

Science communication 20

This research 25

Research environment: Plant breeding 29

Present dissertation 32

The effects of a technological name on inferences, prejudice and public understanding 35

Introduction 37

History of understanding and attitudes from a cognitive perspective 39

Understanding new concepts 42

Expertise 45

The effects of a name 48

Learning by analogy 51

Discussion and Conclusion 53

Genomics? That is probably GM. The effects of a name on the interpretation of a technology 59

Introduction 61

Method 68

Results 72

Discussion 78

Conclusion 83

The effects of the name "genomics" on emerging attitudes in the Netherlands and Ukraine 85
Introduction 87
Netherlands study 95
Ukrainian study 102
General discussion 106

The elephant in the room: How a technology's name affects its interpretation 111
Introduction 113
Study 1 120
Study 2 127
Study 3 131
General discussion 135
Conclusion 137

General Discussion 141
Introduction 143
Summary of the results 144
Theoretical implications 148
Practical implications 155
Limitations and further research 160
Conclusions 165

References 167
Summary 181
Samenvatting 186
Completed Training and Supervision Plan 191
Acknowledgements 193

General Introduction

Introduction

Public attitudes can make or break the successful adoption of technological and scientific innovations. Following the failed introduction of controversial innovations in society – genetic modification (GM) being one of the most prominent examples – public programmes aimed at preventing unfavourable attitudes have become an integral part of many technological and scientific developments. Such public programmes often try to inform or – more ambitiously – educate the public, and some of them even offer opportunities to participate in shaping the innovations. During such public reach-outs, technical experts and scientists[1] find themselves in a variety of situations where they talk with the public about their technological innovations. Often, they use their own ‘expert language’, or, at the very least, the (technical) name of the innovation on which they are working. And once an innovation is introduced into society, the name continues to represent it.

For the uninitiated, a scientific name can be hard to understand. A good example, used as a case throughout the current dissertation, is the name ‘genomics’. It is difficult to explain the meaning of genomics to people who do not have much related expertise. Ever since I started working on this dissertation that you are about to read, when people asked me what my research was about, their first reaction to my answer was “Genomics? What is that?” And in the vast majority of cases, at one point or another, people would present their own answer, which would be something similar to “… is it some kind of genetic modification?” My own experience is similar to that of Van Dam and De Vriend (2002), who noticed that people gave their opinion about GM when they were asked about their feelings towards genomics, and they were of the impression that people believed them to be one and the same thing. Truth to tell, when I read the advertisement for the position that I shall hold until shortly after the publication of this dissertation, I had no idea what genomics was. My first guess was the same as that of most other people; that is was

[1] To avoid confusion between technical scientists working on innovations and social scientists studying public perceptions of innovations, both are henceforth referred to as experts.

a form of GM, and I remember that the information I found did not convince me otherwise.

In the case of genomics, reaching out to the public achieved the opposite to preventing unfavourable attitudes because of the name *genomics* and the associations it triggers. Genomics is explained in more detail later, but at this point it suffices to say that, contrary to GM, it does not entail the controversial artificial recombination of genes (or 'messing around with genes') to breed new cultivars of fruits and vegetables. Rather, genomics can be, and has been, applied as an alternative to GM to try to accelerate the breeding of new plant cultivars. An institution with this objective is the Centre for Biosystems Genomics (CBSG), which has the explicit goal of creating new food cultivars that would meet the approval of people rejecting GM by using genomics instead. When the centre sought partners among those who rejected GM, such as organic farmers, the initial responses were hostile rather than welcoming (Hall, 2010), despite having shared goals in avoiding GM. Why? The potential partners thought that genomics *was* GM and some were already put off by the name of the CBSG. In the case of the organic farmers, elaborate talking and explaining did remove the confusion, and this group became supportive of the approach. However, explaining the differences took a long time and personal attention, and a meeting to discuss possible cooperation was completely taken up with explaining the scientific concept (Hall, 2010). Similar confusion by others caused damage that was practically impossible to correct. Writing about the formation of the CBSG, a journalist in a nationwide newspaper wrote that the aim of the CBSG was to work on "… genetic modification of both the tomato and the potato…" (Janssen, 2002, p. 10). Confusion due the name caused the exact opposite of what was desired, and it spread by mass media, potentially alienating those who might be most supportive.

The name of a technology is always present when people communicate about it, and so is its influence on perceptions of the technology. For experts developing new technologies that are initially shared among the science community only, it often makes sense to choose names that describe the technical nature of the innovation and that are meaningful to their peers. Subsequently, however, these 'expert names' trickle down to society and reach laypeople. At this stage, the initial technical names are not changed, and the effects of these names on people without related expertise are not examined. However, the abovementioned effects of the name genomics suggest that a scientific name can influence the development of initial understandings and attitudes. Instead of refraining from forming an opinion and awaiting further information, the potential partners had already formed unfavourable attitudes that were difficult to correct because of associations activated by the name.

If a name does indeed play such an important role, understanding how it influences perceptions will aid science communication. Not only might it be possible to avoid inappropriate beliefs and attitudes, but also more correct understandings and favourable attitudes could similarly be promoted. The term *lab meat* having run into the same issues as genomics, Friedrich (2016) argued after proposing a new name:

> 'First impressions are critical. We don't want to start a discussion by having to disabuse people of negative associations and inaccurate assumptions; we want to start with a discussion of one of the key advantages.'

Looking at a name as a prime (as Friedrich does) offers a possible explanation for its effects on understandings and attitudes. When a name is acting as a prime, it asserts an influence over cognitive processes that follow exposure to it, including noticing further provided information or remembering information learned previously, the interpretation and processing of that information, and the subsequent evaluation and attitude formation (Sedikides & Skowronski, 1991). This might sound like common sense; however, the negative consequences of names such as genomics, genetic manipulation, and nanotechnology show that it is often noticed only in retrospect that the name has a powerful influence in shaping public perception. When new technologies are introduced into society, the focus is on informing or educating the public. It is not anticipated that names will influence the formation of understanding and evaluations. Once associations are in the process of formation, it might be easy to recognize them, but even then many questions remain. How universally do the associations occur? Do people rely on them to draw conclusions, or do they refrain from making any until they have more information? And, very important, are the inappropriate associations and inaccurate assumptions easily corrected by providing information, or will the interpretation of the information be transformed because of the associations?

A deeper understanding of how a name influences perception and evaluations can have significant practical relevance for communicating about science. Thinking about the potential of a particular name before engaging in contact with the public could be a beneficial first step in public communication efforts. To better anticipate the effects of a name however, it is important to understand why a name carries such weight and what its relations are with both understandings and attitudes.

The aim of the current dissertation is to systematically investigate the influence of a name on the interpretation and evaluation of a science or technology. It focuses on how people make sense of what a name means and on the subsequent formation of attitudes that occurs when people are confronted with a scientific concept unfamiliar to them. The development of genomics applied to plant breeding provides an excellent case to study the effects of a name on emerging attitudes and understandings. First of all, people are still widely unfamiliar with genomics and have therefore not yet formed an opinion about it (Sturgis, Brunton-Smith, & Fife-Schaw, 2010; Pin & Gutteling, 2008). In addition, as the aforementioned sources show (Hall, 2010; Van Dam & De Vriend, 2002; Janssen, 2002), people quickly draw conclusions after hearing the name genomics and before learning more about it. The research is designed to have practical relevance in situations that experts and members of the public can encounter. To achieve this, the individual studies draw on the experiences of researches from the CBSG.

In the remainder of the introduction, topics central to this dissertation are discussed in more depth. First, the effects of a name are explored with a short overview of names that are believed to be either problematic or well-chosen, with their (suspected) effects on public perception and attitudes. In addition, the review explores how experts deal with scientific names. Second, (the lack of) attention on the influence of a name on interpretation and evaluation in science communication research[2] is further explored. In several ways, the basic assumptions behind the current research diverge from dominant views currently found in science communication. Therefore, special attention is given to how the current work relates to, and differs from, those views, followed by an outline of the current research. In addition, genomics itself and the differences between it and GM are discussed in more detail. At the end of the introduction, the structure of the dissertation is presented more broadly, with a short description of the studies and the relation between them.

Names influencing perceptions: An overview

Within the field of science communication research, reports about the effects of a name on understanding and attitude formation are difficult to find. A strong focus on education and participation offers a possible explanation: in the view of well-informed experts, making assumptions about the nature of a science or technology based on just a name borders on prejudice and bias, which should be corrected by education or participation. And with the goal-oriented view on these interventions, even reporting interferences of a name is not a priority (see section Science communication, later in this chapter). However, although sparse and scattered, reports on the effects of names can be found. Some of the reports show how a name can cause confusion, whereas other reports give examples of successfully getting a message across by changing technical names to ones more meaningful to the public. Although the majority of these sources do not report the

[2] In many ways, the current research is inspired by the sub-discipline, *public understanding of science*, which focuses especially on changing attitudes towards science by enhancing understanding through providing information. Because of the interest in the effects of names used during (not necessarily educational) communication on understanding and attitudes, the current research fits in both the (broader) theme of science communication and that of public understanding of science. For clarity, the term science communication is henceforth used exclusively and can refer to each one or to a combination of both.

result of systematic research, they do shed light on how a name can cause confusion or promote understanding. In addition, some also show how experts approach issues arising from names and why more attention on the subject is needed. The overview begins with a further exploration of three names that have been suspected of causing unfavourable attitudes among the public; these are genetic manipulation, nanotechnology, and genomics itself, which is discussed first.

Confusing names

As already mentioned, Hall (2010) and Van Dam and De Vriend (2002) report that, in their experience, people confuse and even replace genomics with GM. To test the influence of the word more directly, people were asked what they thought the word genomics meant (Nap, Jacobs, Gremmen, & Stiekema, 2002). The majority of respondents believed it to be "… a difficult word for genetic manipulation" (Nap et al., 2002, Appendix 1).

It can be argued that people consciously treat genomics and GM as synonymous because of the technical similarities between genomics and GM, and the fact that knowledge derived from genomics can be used for GM. However, both Hall (2010) and Van Dam and De Vriend (2002) note that people lack any clear knowledge about either genomics or GM; this is in line with earlier findings that people have very little knowledge about GM (Frewer, Shepherd, & Sparks, 1994) and that the public are (still) unfamiliar with genomics (Sturgis et al., 2010). So, although genomics and GM share technical aspects and can be used to complement each other, people do not have, and therefore do not use, this knowledge to link the two. Rather, people treat genomics and GM as similar solely because of similar sounding names. The lack of technical knowledge also explains why it is so hard to correct misunderstandings, as reported by Hall (2010); it is next to impossible to illustrate the technical differences between GM and genomics briefly when someone has very little knowledge about either. To fully appreciate the differences, one needs to have relatively extensive knowledge of the theoretical basis, in this case genetics.

Much like the name genomics, nanotechnology is reported to trigger incorrect beliefs. Kampers (2009) reports that people, when confronted about nanotechnology applied to food production, believe that “nanotechnology equals nanoparticles”. According to Kampers, nanoparticles are considered dangerous by most people because of well-known hazardous nanoparticles (such as asbestos), and therefore nanotechnology is equally considered dangerous. In reality, only a small subset of nanoparticles is dangerous, and those applied to food are harmless according to Kampers.[3] In addition, nanotechnology does not necessarily result in nanoparticles (Kampers, 2009). Similar to the case of genomics, the public have only little knowledge about the science involved. In Kampers’ (2009) experience: “…the general public lacks the technical ability and the information to make a good risk assessment” – a statement supported by findings from research on the public knowledge of nanotechnology (Cobb & Macoubrie, 2004; Lee, Scheufele, & Lewenstein, 2005)

Another similarity between genomics and nanotechnology is that the names have not fully reached the public domain, and experiences with effects of the names are therefore still limited. The name genetic manipulation is suspected of having done considerable damage already after the technology, its products, and its name were introduced into society. After the technology attracted widespread criticism and controversies started to mount, the name came under suspicion of being partly responsible because of negative associations triggered by (social acts of) *manipulation*. As a form of damage control, it was replaced with the nicer sounding alternatives, engineering and modification (Bauer, Durant, & Gaskell, 1998; Hansen, 2010).

[3] Not everyone agrees with this notion. Calls for more research and more caution in applying nanotechnology (Maynard, 2008) have been made (Faunce, Murray, Nasu, & Bowman, 2008). In an article discussing the differences between laypeople’s and experts’ perception of nanotechnology hazards, Siegrist, Keller, Kastenholz, Frey, and Wiek (2007) pay special attention to the remarks of reviewers who question the ability of experts to judge the risks of nanotechnology (see Siegrist et al., 2007, p. 60). These authors conclude (like Kampers, 2009) that experts use their technological knowledge, but they explicitly state that they “…do not make any claims about the accuracy of the experts' assessments” (Siegrist et al., 2007, p. 67). For the current dissertation, the main point is that the expert notices how people use associations to transfer mainly risk perceptions from familiar nanotechnology applications to new ones.

A few interesting commonalties can be found between the cases of genomics, nanotechnology, and genetic manipulation. First of all, the public have little technical knowledge about the subjects. Second, in the cases of genomics and nanotechnology, people give meaning to these constructs by comparing them with, or even replacing them by, concepts with which they are familiar. In the case of GM, it is believed that the act of manipulation causes a link with the act of social manipulation. People therefore appear to try to understand concepts with which they are dealing by finding concepts similar in appearance with which they are already familiar.[4] This behaviour appears to follow patterns described in categorization theory, as discussed next.

Categorization theory

According to categorization theory, human knowledge is organized in categories of similar concepts (Rosch, 1975, 1978). By grouping similar concepts together, one does not have to remember every detail about each member belonging to the category, resulting in cognitive efficiency. It also helps to deal with new concepts. Inferences about the new concept can be made by placing the unfamiliar in an existing category (Moreau, Markman, & Lehmann, 2001), an act called categorization. If someone proverbially concludes that something is a duck because of its looks, the same person will be able to make inferences quickly and efficiently without direct observation or testing, such as that it can swim. Categorization theory has been developed mainly by studying the way people mentally organize natural objects (Dutton & Jackson, 1987) or physical products that appear similar in shape, dimension, or function (see Mervis & Rosch, 1981; Rosch, 1975, 1978; Rosch, Simpson, & Miller, 1976). The similarity between how people link technologies by name alone and the way people categorize objects suggests that categorization also applies to making sense of scientific names, even though a name lacks the rich set of stimuli objects that can be used to justify a categorization.

[4] Familiarity in the current sense does not imply having technical knowledge.

Names avoiding confusion

The examples of names that act confusingly consist of cases where the expert names continued to be used during the (emerging) public interactions. In a number of cases, experts have altered the name of a technology or science to avoid inferences. A recently introduced example is the current attempt to come up with an alternative name for lab meat, and its synonyms *synthetic meat*, *in-vitro meat*, and *culture meat*. There are concerns that the names lab meat or in-vitro meat bring a 'yuck factor' to impressions about the meat (Rousseau, 2016). In addition, it is feared that the names might lead to confusion about the production methods (Mammoser, 2016), and that the term culture meat could lead to confusion (or mis-categorization) with otherwise treated meat (Friedrich, 2016). Changing the name to *clean meat* serves two purposes (Friedrich, 2016): it is supposed not only to avoid confusion, but also to trigger associations stressing its benefits.

For a similar reason, the name *nuclear magnetic resonance* (NMR) was changed to *magnetic resonance imaging* (MRI). The renaming occurred when use of the technology was extended from chemistry and physics to medicine. At this point, not only would laypeople come in contact with, and communicate about, the subject, but also would be placed inside the scanners. This raised physicians' concerns that the name nuclear would lead to people falsely assuming that they would be bombarded with dangerous nuclear radiation. To prevent people from becoming anxious over (non-present) ionizing radiation, *nuclear* was dropped in favour of *imaging*, which emphasizes the function rather than its technological foundation (Meaney, 1984).

A name that is considered highly successful in communicating a complex idea is *ozone hole*. Rowland, a pioneer in ozone depletion, came up with the name to communicate effectively about the phenomenon (Grundmann, 2002, p. 102). Scientifically, the term hole is incorrect and too simplistic to describe the process theoretically; depletion is used instead. However, ozone hole served as an effective metaphor to illustrate the problem on a popular level and is regarded as largely responsible for focusing public attention on the problem of ozone depletion because it created an easy-to-grasp picture of the problem (Grundmann, 2002).

The relation between a name and understanding: Empirical research

The lack of empirical research means that the extent to which communication benefited from changing the names remains uncertain. The term ozone hole was successful in attracting the public's attention (Ungar, 2000). However, the effects of names compared to their alternatives remains somewhat speculative due to the lack of direct empirical attention. In a notable exception, Whitmarsh (2009) compared perceptions triggered by *global warming* and *climate change*. In good scientific practice, global warming and climate change refer to different consequences of increased carbon dioxide concentrations (Conway, 2008). They are, however, used interchangeably (Conway, 2008; Corbett & Durfee, 2004), and journalists tend to use global warming rather than climate change (Corbett & Durfee, 2004). Whitmarsh (2009) shows that global warming is more often associated with, among other things, melting glaciers and human activity. Thus, Whitmarsh (2009, p. 416) provides direct evidence that, in her own words, "the terminology used determines the way people understand and evaluate the issue". The research thereby shows that explaining scientific ideas can be easier with some names than with others.

Science and 'public names'

As stated, the unexpected effects noticed by experts when attempting to communicate with the public using terms like genetic manipulation, genomics, and others show that it is not just common sense that a name can have such a powerful influence. The name is not a priority, creating a blind spot as illustrated by the name genomics. During the preparation phase in which the CBSG was formed, there were already warning signs pointing to the name being problematic (see the abovementioned confusion reported by Van Dam & De Vriend, 2002; Janssen, 2002; Nap et al., 2002; see also Gremmen, 2007). In addition to the blind spot, the scientific community shows an unwillingness to adopt alternative names that are proving themselves useful. In the case of relabelling NMR as MRI, a group of experts argued for rejection of the new name. Instead of agreeing with the advantage of effective and clear communication and avoiding unnecessary confusion and fears, they argued that confusion caused by the name NMR should be resolved with education (Pohost, Elgavish, & Evanochko, 1986). In a similar vein, the name ozone hole was initially rejected and banned from use in journals because of its inaccuracy (Christie, 2001; Grundmann, 2002). Even though both public names became the standard, the reaction shows an interesting dichotomy in experts' approach to the public. On the one hand, public communication has become an important part of science; on the other, experts typically tend not to think about the interference a name can have. When some do, others criticize potentially effective names for not being scientifically correct. By doing so, they place more importance on traditional scientific labels than on efficient and effective public communication.

Conclusion

Although limited in number, the above cases show some interesting patterns. The first and most certain observation that can be made is that the attention on a name in science communication literature is rather slim. This might be considered surprising, as the name of a topic plays a very important part in communicating about it. When the subject of naming does receive attention, it is often related to directly experienced, practical issues and lacks an interest in theory development. The lack of a theoretical interest is even illustrated in the case of the research about the different beliefs triggered by global warming versus climate change: although it is one of the very few direct tests of the effects of a name, the theoretical outline of the research deals not with theories about why the differences arise, but rather with theories about the (ecological) importance of climate change.

Second, the interferences from a name appear to result from people believing that they are dealing with another technology. Thus, it appears that people draw conclusions from a particular categorization, with the categorization being determined by the name of the technology rather than by its technical attributes. In addition, those who have changed names, do so with a clear focus on how to get a point across to the public. They aim to choose a name that prevents incorrect categorization by those with limited technical knowledge while simultaneously illustrating the technology's benefits.

The findings also point to an important influence of the domain of application of a technology. In all the cases where experts are confronted with unfavourable responses, the technologies, genomics, GM, nanotechnology, and lab meat, are applied to food production. It has been speculated that, because of the intimate connection between people and food, technologies that modify food might be especially prone to scrutiny (Frewer, Howard, Hedderley, & Shepherd, 1997; Marris, Wynne, Simmons, & Weldon, 2001; Pardo, Midden, & Miller, 2002; Bánáti, 2011; Simons et al., 2009). The pattern of topics leading to issues appears to confirm this.

Finally, the public's knowledge level is a recurrent theme. In several cases, the experts conclude that the public are not knowledgeable enough to draw the right conclusion. A lack of technical knowledge about what to use to form an understanding can explain much of why people would fall back on a name to reach conclusions. However, statements about the public lacking knowledge are often met with suspicion (especially within science communication research) because of the way these have been used by experts to maintain control over science. Because of the central role of understanding and a lack thereof in current research, special attention is given in the current dissertation to how a lack of understanding and ignorance is approached and how this approach differs from dominant views in science communication research.

Science communication

Evolution and limitation of the dominant approach in science communication

In recent decades, a public that initially celebrated science are now becoming more critical (Gregory & Lock, 2008). Fuelled by controversial technologies such as nuclear energy and GM (Gregory & Lock, 2008), people have started to fear and reject scientific developments and to mistrust experts (see also Löfstedt, 2005). The lack of public support put pressure on the funding of research

(Gregory & Miller, 1998; Yearley, 2000). One of the scientific community's most influential responses was the publication of the report titled *The public understanding of science* (Bodmer, 1985). The report presented what has become known as the deficit model; it postulated that people feared and objected to scientific developments because they lacked the knowledge required to understand things properly. The solution presented was public education, which would solve the resistance by imparting a proper understanding. In attempts to prevent further unfavourable opinions, public educational programmes started to spread, and science communication became an integral part of scientific developments. Related research reached the point of itself becoming a subtheme of science communication, called public understanding of science after the report.

The deficit model continues to influence science communication, even though it has proved unsuccessful in changing and preventing unfavourable attitudes (Bauer, 2016). One reason is that alternatives to the deficit model closely resemble it (Wynne, 2006). The deficit model's educational approach, in which the public are more or less passive receivers of 'correct facts', has been replaced with approaches in which members of the public play a more active role (Gregory & Lock, 2008). According to supporters of public participation in scientific developments, the public in their active role become co-creators of science through changing the course of science by voicing wishes and objections. According to Wynne (2006) however, the deficit mode of thinking remains; although education is replaced with participation, the aim is still to prevent unfavourable attitudes rather than truly give control to the public. Second, the deficit model continues to remain popular among technical experts and policymakers (Kerschner & Ehlers, 2016). Consequently, much current science communication is still influenced by the deficit model (Miller, 2001; Bauer, Allum, & Miller, 2007; Durant, 1999; Bauer, 2016).

The deficit model has become very controversial (Bauer et al., 2007; Durant, 1999; see also Bauer, 2016). Those who object believe that it is undemocratic not to accept people's opinions but rather to call for education when the public hold different beliefs. To make matters worse, opponents of the model believe that the idea that people are ignorant is used derogatively with the aim of disqualifying people from the debate and retaining control of scientific agendas (Wynne, 1993; Durant, 1999). Experts are indeed known to express themselves in accordance with these suspicions, including calling people lazy for not becoming educated and being too quick to draw conclusions (Bucchi, 2008), and saying that important scientific decisions should not be left to the ignorant public. Behaviours like these cause suspicion around remarks such as that of Kampers (2009) that the public lack the technical ability to make a good risk assessment about nanotechnology. In science communication research, the dominant view is that science should be more democratic. To counter the lack-of-knowledge argument, a dominant view is that the public do understand, just not in the way experts do. Instead, people form what is known as *lay expertise*.

Regarding understanding itself, the argument that the public understand differently makes a valid contribution to bridging the gap between the public and experts. However, the fact that understandings can take a different form does not take away from the fact that people can misunderstand (Davies, 2008) and that ignorance does exist. As illustrated by the case of organic farmers confronted with the word genomics, the difference in understanding (the public drawing conclusions based on the name versus experts' deep theoretical understanding) leads to a belief that genomics equals GM; a different but also an inappropriate conclusion.[5] This also shows that the concept of lay understanding does not suffice to reject ignorance. Putting a moratorium on misunderstandings and ignorance can create a blind spot not only on how misunderstandings arise or the effects of ignorance, but also on offering solutions to them. It prevents the development of insights about how people reach the wrong conclusion, why they draw conclusions so quickly, and what the

[5] The conclusion that non-experts reach 'inappropriate' or 'wrong conclusions' has often been used by experts to disqualify public opinion, while claiming that they themselves are 'right' (Hansen, Holm, Frewer, Robinson, & Sandøe, 2003). Thus, claims that non-experts are wrong can be highly political (Maranta, Guggenheim, Gisler, & Pohl, 2003) and met with suspicion. However, this of course does not mean that non-experts cannot be wrong. Within the current confusion between genomics and GM, it can be argued that the farmers concluded themselves that they had drawn an inappropriate conclusion when they changed their mind after developing a deeper understanding.

effects of the initial misunderstanding are on further knowledge development, if it does take place. Despite the good intentions, denying that misunderstandings and ignorance exist actually damages the potential for recognizing that people can understand differently.

The above opposing views between experts and social scientists can offer a second possible reason for the lack of attention on the effects of a scientific name. In a situation where social scientists are focusing on promoting the idea of a general (lay) understanding by the public, recognizing misunderstandings caused by a name or focusing on its role in enhancing the efficiency of educational efforts might come across as agreeing (or even siding) with experts. Experts, on the other hand, tend to be surprised that a name can cause misunderstandings at all. As experts judge scientific developments on their theoretical content, jumping to conclusions after reading a name might come across to them as silly. Experts might especially not expect it because of their own analytical nature. Consequently, a name as a research topic seems to be lost between social scientists' sensitivity to recognizing misunderstandings and ignorance and experts' surprise at the fact that it can have such an impact.

To pay proper attention to how the public respond to a name, an explicit attempt is made not to be caught in the rival views of a derogative 'ignorant lazy public' view versus a 'lay understanding' stance. The approach taken in the current dissertation is that people can misunderstand and that they can be, and very often are, ignorant.[6] However, this is done in a non-derogative way, and ignorance is not regarded as the result of laziness (or as stupidity). The best way to illustrate the current approach is to consider ignorance as a form of bounded rationality (Simon, 1979). According to Simon, it is impossible to know everything and the cost of searching for all related information is too high for it to be practical. This view that it is too costly is strengthened by research on expertise, which states that it takes about 10 years to reach the level of being an expert (Ericsson, Krampe, & Tesch-Römer, 1993), and that, in the case of science communication, it would take a lot of

[6] In fact, everyone is (relatively) ignorant about any subject about which they are not an expert, constituting the vast majority of subjects.

study to really grasp information being provided in the way intended by experts about even only *one* subject.

The sheer amount of information that people have to process to gain a basic understanding brings forth another difference between the current dissertation and dominant views in science communication. Science communication research often focuses on how people respond to information provided. Consequently, it often deviates from daily life situations where no information is present. Science communication (which reaches only a small subset of the population) is therefore often an intervention itself that causes participants to be more informed than the public they are supposed to represent. Because of the intervention, science communication studies mostly the psychology of the informed. In daily life situations, we often make decisions and form attitudes and understandings with many questions unanswered, because we have to. Externally provided (technical) information is often an exception to the rule.[7] Reasoning from the perspective of the development of knowledge about a particular subject, ignorance is often the basis on which attitudes and understandings begin to take form, on which we base many decisions in life. To understand related behaviours and opinions, a *psychology of the uninformed* and barely informed is needed.

The current research is based on the view that people will often not develop well-founded insights. It is reasoned that ignorance is most often the default state of knowledge, which will most likely not alter significantly because of a lack of personal urgency and high cost. Therefore, in daily life situations, people often have to deal with complex technologies without the related technical knowledge that experts have. For some technologies, they have only the name and the associations it triggers to go on when making decisions, making the name a very important factor in shaping people's understandings. To understand these processes, it is important to research not only how people respond to information, but also how they respond without it. Therefore, the current dissertation differentiates itself from the dominant

[7] Many people might be targeted by marketing. However, the information provided is aimed at enhancing consumption rather than understanding, and therefore marketing is not considered externally provided information in the current context.

tradition in science communication research with the aim of understanding the formation of attitudes and understandings, without any other information than the name.

This research

The aim of the current research is to gain insight into the role of the name of a technology in shaping attitudes and understandings about it. The research draws its inspiration from the observation that perceptions and subsequent attitudes about a technology can be influenced strongly by its name. The current research goal is to systematically investigate the effects of the name of a technology on its emerging understandings and attitudes. It is argued that most people will form opinions not based on publicly provided knowledge or education, but on emerging understandings and attitudes that can be strongly influenced by a name.

At the centre of the research is the initial phase of how people form their understandings and attitudes. Therefore, it explores people's reactions to an innovation before information has reached them. In this approach, the hypothesis is that the name can play a central role in shaping the public's understanding and responses through the associations it triggers. In the research, this is investigated by looking at whether people universally show a pattern between the evaluation of an unfamiliar technology and that of a familiar one based on the name. Such a pattern would confirm the tendency to categorize an unfamiliar technology with a familiar one to reach an evaluation. The lack of such an outcome would indicate people restraining their evaluations, which would be closer to the expectations of experts.

In addition to just the influence of a name, the context in which a science or technology is presented can have an important impact in activating cognitions. It is often argued that controversies are more hotly debated when innovations are applied to enhance food production. For example, it is argued that GM is especially controversial because it is often applied to food production systems (Frewer et al., 1997; Marris et al., 2001; Pardo et al., 2002). Supporting this notion is the fact that debates about GM and restrictions on applying it often occur in an agriculture-for-food context. Applications and restrictions in relation to medical or industrial applications are far less common, and public awareness of these applications is low (Marris et al., 2001). Thus, it can be hypothesized that applying a technology to food production appears to increase the sense of risk. Research has shown that people tend to use broader categorizations when they have a high risk perception; this can result in more associations and categorizations with other technologies that are perceived as risky when people are trying to make sense of a concept (Shook, Fazio, & Eiser, 2007). To test the influence directly, the current research also investigates the interaction between the name of a technology and the presented application. It is hypothesized that there are more associations activated with other familiar technologies that are perceived as risky for (the name of) a new technology in a food-production context compared to other applications of it.

Further, the current research also pays attention to what happens if information is provided, as is often done in science communication. However, the current assumption is that, when information is provided, the name still plays a crucial role in the ‘sense making’ of the information through activated mental categories, which can determine which information is noticed and remembered. It is therefore expected that the effects of the information can be influenced by cognitions activated by the name. Put differently, the extent to which the effects of providing information are the result of the interaction between information and the expectations triggered by the name is investigated.

In the current dissertation, the role of a name is explored using the name genomics as an example. It follows up on the aforementioned experiences of the CBSG experts that people universally respond as if genomics is GM and that it is difficult to explain the differences. It is important to note that the term genomics can refer to other technologies and practices outside plant breeding. However, genomics is the standard term used by experts to describe genomics applied to plant breeding[8] to communicate both among themselves and to the public (as illustrated by the name Centre for Biosystems Genomics). The current research aims to approximate the

[8] Two full names for genomics are applied to plant breeding; these are genomics accelerated breeding and genomics assisted breeding, see the section Research environment: Plant breeding, later in this chapter. These are, however, not used much and mostly abbreviated to just genomics.

situation as encountered by these experts. Therefore, the name genomics refers to genomics accelerated breeding, and the effects of the name are studied in the context of plant breeding for food.

The effects of the name genomics are investigated by comparing them to the effects of an alternative (fictional) name for genomics. The alternative name is chosen on the same logic behind the names clean meat and MRI; clean meat is a name that emphasizes the advantage of the technology, whereas MRI avoids unnecessary fears or controversies. In the case of plant genomics, the main advantage concerning public opinion consists of circumventing the controversial artificial recombination of genes. Instead, the crossing of favourable traits is accomplished through natural, sexual recombination. On this basis, the fictional name *natural crossing* is chosen as an alternative to the name genomics.

Approach

The research is experimental in nature and in the tradition of cognitive psychology, a sub-discipline of social psychology. Cognitive psychology research predominantly entails experiments that attempt to discover what happens in people's minds when they process information, making it a suitable approach to investigate how people deal with scientific concepts with which they are unfamiliar. Cognitive psychology research can be distinguished from other social psychology research as it focuses on how people process and apply information in social situations, and not merely on behavioural outcomes (Anderson, 2009). Before modern cognitive approaches emerged, psychology was dominated by behaviourism (Schultz & Schultz, 2015), which describes human behaviour as largely determined by a stimulus–responses mechanism (Skinner, 2011). Central to cognitive approaches is the notion that people actively process information and that differences in processing can result in differences in outcomes (Wyer, 2014). Differences in processing can be caused by almost anything present in a given situation, including elements both in the environment and internally in the evaluator. These elements include alternatives presented to which to compare a stimulus, an opportunity to process, knowledge about the subject, and motivation.

An important aspect of the cognitive approach is that even small differences can cause different – and sometimes even opposing – evaluations. The following two examples show how people interpret and use information in processing information to reach different evaluations. First, life satisfaction is rated higher if a person is asked about life satisfaction first and then about marriage satisfaction, than the other way around (because when someone is asked about marriage first, the joy it brings will most likely not be excluded spontaneously in the evaluation of life satisfaction; Schwarz & Bless, 1992). Another powerful example is an experiment presenting a child custody battle. Respondents were presented with two candidates for custody: a very successful but busy parent and an averagely successful but often available parent. One half of respondents were asked which candidate should get custody, the other half which one should *not* get it. Both groups predominantly picked the same candidate: the successful, hard-working one. The first question made respondents focus on success, whereas the second made them focus on lack of availability (Shafir, 1993).

Science communication research interested in public perceptions often consists of interviewing people about their opinions and analysing debates. The answers and opinions stated form the basis of the conclusions about how people currently judge the scientific developments of interest. The above examples of cognitive research, however, show that opinions and evaluations might be different depending on the information presented in the debate or associations triggered by situational factors that people use to arrive at an evaluation by comparing. To be able to illustrate these differences, research in the cognitive psychology tradition primarily takes the form of tightly controlled experiments using different experimental conditions, of which the results can be compared. The different outcomes between experimental conditions provide information about the mental processes that take place during the processing of the information. In the current research, this experimental approach is used to shed light on these mental processes. Thus, the current research aims to contribute to science communication by learning more about how people form an opinion rather than to establish what their exact opinion is.

Research environment: Plant breeding

In order to study emerging understandings and attitudes, the current focus is on plant genomics applied to food purposes. Plant genomics is a relatively new development in the history of plant breeding. Plant breeding has been practiced for thousands of years and is described by the Journal of Plant Physiology & Pathology (n.d.) as “the art and science of changing the traits of plants in order to produce desired characteristics”. Frequently cited examples of such desired traits are the ability to sustain harsh conditions, tolerance to pests, and improved yield (see for example Boyer, 1982; Dalal, Dani, & Kumar, 2006). A powerful example of the immersive effects that plant breeding can have is Borlaug’s work. By crossing different cereal grains, he was able to vastly increase yields of the crop (see Borlaug, 1968). The impact of this work alone on food security has been so enormous that he is often credited with having saved over a billion people from starvation.

The purpose of plant breeding is to create a cultivar. A cultivar, a portmanteau word from ‘**culti**vated’ and ‘**var**iety’ (Concise Oxford Dictionary of Current English, 1990, p. 282) is a new variety that has characteristics that can be maintained by propagation. Although a plant variety in the wild can be used as a cultivar when it has desired characteristics that can be maintained, the majority of cultivars are purposely created by breeders with the aim of creating a new combination of characteristics that did not exist previously. In the remainder of the dissertation, the term cultivar is used to refer to purposely created varieties.

An important way to create new cultivars is classical breeding, also called traditional breeding (Acquaah, 2007). Traditional breeding involves the inbreeding of plants that are related to each other to achieve a combination of the unique characteristics of the plants used (Poehlman, 2013). For example, a plant with many tomatoes can be bred with a plant having tasty tomatoes in an attempt to create a plant with many tasty tomatoes. Traditional breeding is a form of sexual reproduction. From this perspective, the goal is to try to create a seed that has both the genes causing many tomatoes from the first and the genes causing the tasty tomatoes from the second.

However, traditional breeding has several disadvantages that impact its usability. A breeder does not know which genes are going to be transferred under traditional breeding; undesirable traits will be transferred just as often as desirable ones. Therefore, trying to weave desirable traits together will require many generations of plants (Allard, 1999). With each generation, plants showing predominantly desirable traits are used for propagation, and an attempt is made to eliminate undesirable traits by disposing of those plants predominantly showing them. Not only do the generations have to grow to the point of reaching fertility, but also in some cases it can take a long time before traits such as taste stabilize; this, however, is necessary to make the proper selection for further breeding. Another disadvantage is that the selection of plants used in traditional breeding depends on observable traits such as taste, because a gene itself is undetectable. However, genes can be present without being detectable. Therefore, a plant can be disregarded for further breeding even though it could be a very appropriate candidate for further breeding because it actually does have the desired gene (Breseghello & Coelho, 2013).

An alternative to traditional breeding is GM. When GM is applied, the gene responsible for a desired trait is introduced into the DNA of a plant having other desirable traits. So, with GM, the gene causing many tomatoes can be introduced into the DNA of a plant bearing tasty tomatoes. The breeder now knows that both the (introduced) gene causing many tomatoes and the gene(s) causing the tasty tomatoes are there, eliminating a lot of the guess works. According to proponents, this makes GM more precise and faster than traditional breeding (Gepts, 2002). Another advantage of GM is that it enables breeders to introduce characteristics into cultivars that are normally found in other species and that are naturally alien to the varieties used. For example, Bt corn has the characteristic of creating an insecticide that protects the crop. This characteristic is not naturally present in corn and is created by introducing genes from bacteria that naturally create the toxin in the DNA of the corn (Saxena, Flores, & Stotzky, 1999). Whereas the recombination of DNA follows the natural process of sexual reproduction, the recombination is artificial when GM is applied.

The artificial recombination of genes is the main reason for the unsuccessful commercial adoption of GM. Many people object to the idea of reorganizing DNA in an artificial (or ‘unnatural’) way, as illustrated poignantly by the term ‘Frankenstein foods’ for GM food products (Cook, 2004). The public’s aversion not only causes consumers to ignore the products, but also has resulted in strict laws concerning production, labelling, and/or import in many countries (Davison, 2010; Federici, 2010; Gruère & Rao, 2007). As a result, breeders take a great risk employing GM when creating new cultivars, especially when they are attempting to make a new food product.

Genomics assisted breeding, a relatively new way of breeding that has emerged with the development of plant genomics, provides some of the advantages of GM without artificially modifying genetic structures. The term genomics refers to both knowledge about the genome, which is the entire set of DNA in an organism, and the technology of applying the knowledge for different purposes such as genomics assisted breeding (Barnes & Dupré, 2009). Genomics assisted breeding can be regarded as a sort of middle-way between traditional breeding and GM, as it shares characteristics with both practices. As with GM, genomics assisted breeding uses knowledge about genes to enhance the speed of development of new cultivars. However, contrary to GM, genomics assisted breeding does not use the highly controversial artificial recombination of genes. Instead, similar to traditional breeding, new plants are created using sexual reproduction. The knowledge about genes and how they function is used after reproduction to check which of the new hybrids are suitable for further propagation. Instead of selecting plants on the basis of traits, such as number of tomatoes and taste, breeders look for the presence of the genes responsible in the newly formed DNA; this can be done at a very early stage and before the traits stabilize (Collard & Mackill, 2008). Although it is still left to chance whether the desired genes are transferred, looking at the DNA directly is a more reliable and faster way of determining whether the desired genes are present (Edmeades, McMaster, White, & Campos, 2004; Collard & Mackill, 2008).

When used by plant breeding experts, the term genomics assisted breeding is often abbreviated to simply genomics. For example, the Centre for Biosystems

Genomics, which focuses on creating new cultivars using genomics assisted breeding, has omitted assisted breeding and uses only genomics in its name and its logo. Genomics is also the mainly used reference to genomics assisted breeding in communication. Following this pattern, genomics is used to refer to genomics assisted breeding in the current dissertation.

Present dissertation

The present dissertation focuses on studying the effects of the name of an unfamiliar technology. The aim is to gain understanding of how a name can influence emerging understandings and evaluations of an unfamiliar technology. An understanding of the influence of a name can be utilized to avoid unnecessary confusions and misunderstandings and to promote communication that fosters understanding. In addition to the effects of a name alone, it is investigated whether the influence of a name is related to other elements of communication. Because technologies appear to achieve a controversial status especially when applied to food purposes, it is investigated whether the influence of the name of a technology is different when it is applied to food compared to another application. It is also investigated whether the provision of additional information influences the effects a name can have. Figure 1.1 provides a representation of the researched mechanism for reaching an evaluation.

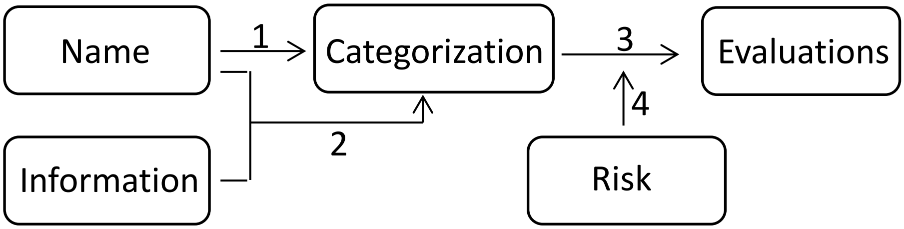

Figure 1.1: Schema of research. For proposed relation 1 see Chapter 3; for relation 2 see Chapter 5; for relation 3 see Chapters 3, 4, and 5; for relation 4 see Chapter 4.

In Chapter 2, the aim is to investigate why and how a name can shape impressions and evaluations about a technology. Using literature sources from psychology, consumer behaviour, and other social sciences, the chapter provides on overview of relevant factors, such as time pressure and lack of information, and mechanisms, such as categorization and attitude extension, in the formation of evaluations and attitudes after exposure to a name. The literature review is carried out from the perspective of the formation of (a personal) understanding of a technology. The chapter presents a view that challenges the deficit model, especially from the perspective of the feasibility of searching for external information in daily life situations.

In Chapter 3, the aim is to investigate whether the name of a technology can determine its categorization. In addition, it is investigated whether the categorization will determine the resulting evaluation. In particular, the aim is to investigate whether the name alone is enough to trigger the process of categorization and evaluation. It is hypothesized that the name genomics will encourage categorization with GM and cause similar evaluations. To investigate the effect of the association, the results are compared to those following exposure to natural crossing, stressing naturalness. It is hypothesized that the alternative name will cause categorization with traditional breeding.

In Chapter 4, the influence of the field of application is investigated. It is believed that GM is especially controversial in the context of food. In addition, people use broader categorizations when confronted with risk. Therefore, it is tested whether people categorize Genomics more readily with GM when it is presented in a food production context compared to a biofuel production context. In addition, it is investigated whether a food production context will lead to more uniform evaluations between genomics and GM. To account for possible cultural effects, the research is carried out in a national context where evaluations about GM are known to be moderate (The Netherlands) and in a culture where they are known to be more unfavourable (Ukraine).

Chapter 5 focuses on the effects of the interaction between the name of a technology and the information given about the technology on the resulting evaluations. The research in the chapter follows the methodology in Chapter 2, except that in this chapter an explanation of what genomics entails is presented. The chapter consists of a series of experiments to investigate the extent to which the order of presentation of the name of a technology and its description causes differences in evaluations.

Finally, in Chapter 6, the findings presented in the previous chapters are summarized and discussed. Theoretical and practical implications are provided. In addition, limitations are presented, as are directions for future research.

The effects of a technological name on inferences, prejudice and public understanding

This chapter is based on: Boersma, R., & Gremmen, B. (2018). Genomics? That is probably GM! The impact a name can have on the interpretation of a technology. *Life sciences, society and policy*, *14*(1), 8.

Abstract

We investigate how people form attitudes and make decisions without having extensive knowledge about a technology. We argue that it is impossible for people to carefully study all technologies they encounter and that they are forced to use inferences to make decisions. When people are confronted with an intangible abstract technology, the only visible attribute is the name. This name can determine which inferences a person will use. Considering these inferences is important: first, a name will reach consumers before detailed information, if any, will. Second, if detailed information reaches consumers, the hard-to-comprehend information is processed using pre-activated attitudes and beliefs. Using the available literature, we explore the impact a name can have on the interpretation of a technology. We argue that science communication can benefit from trying to develop a name for a technology that activates proper beliefs to guide non-experts to a more meaningful understanding of it.

Introduction

People often come in contact with a new technology in situations where they have hardly any relevant knowledge or information. In situations like these, a name can be very influential. For example, imagine yourself going shopping for your favourite food. When you arrive at the place where your favourite dish is sold, you suddenly notice that, besides the regular food you are used to buying, there is a new option. This option is produced using a technology called *next gen-radiation*. How will you give meaning to this new technology, in the middle of the supermarket, without books, internet or experts on the matter to explain to you what it is? What information will you use? Without anything else, you only have the name to go on.

Genetic manipulation is a good example of a technology name that influences perceptions. To manipulate means to control, and so from a technological perspective the term gives a good representation of what the technology entails from an expert perspective. Unfortunately, when the term reached the public, people became suspicious of it, and so the term itself contributed to the negative perceptions towards the technology because of the negative connotation of manipulation (Hansen, 2010). In an attempt to reverse the damage, the name genetic manipulation was changed to *genetic modification* (Hansen, 2010). This shows that the term used is regarded as an important factor in the interpretation and acceptance of the technology.

Currently, a new approach to genetics is being developed under the name *genomics*. The term genomics can refer both to the science of genomics, which is the study of the genome, and to the application of the science, for example genomics-assisted breeding. Applied in plant breeding, genomics-assisted breeding can be used to create new crops more efficiently by using knowledge on the relation between genomes and traits. Genomics is similar to traditional breeding in the sense that crops are combined through sexual reproduction to create a new variety. Genomics enables plant breeders to check whether the genome of the new variety contains the parts that can cause the desired traits without having to wait until the parts come to expression, thus accelerating the process significantly. It differs from genetic manipulation, where traits are introduced artificially. Therefore, genomics can serve as an alternative to this controversial technology and is even being promoted as such by Greenpeace (van Aken, 2009), one of the major opponents of genetic manipulation.

Unfortunately, even though genomics circumvents the main objection against genetic manipulation, people react very similarly to the technology (van Dam & de Vriend, 2002). It appears that the similarity of the names is affecting the perception of genomics negatively. In a Dutch study on perceptions about genomics, the authors conclude that the respondents do not know what genomics is and that they have difficulty understanding all the information they receive (van Dam & de Vriend, 2002). Nevertheless, they answer the question posed to them as if they do understand. The authors speculate that the respondents are actually using knowledge about genetic manipulation to formulate answers. In fact, they observe that different respondents automatically use the term genetic manipulation, especially when genomics is mentioned in the context of plant breeding.

The essence of the problem in the case of both genetic manipulation and genomics is that people who do not know much about the related scientific or technological concepts react in a way that is unexpected by experts, i.e., as if they do have knowledge about the concepts. When conflicts arise, scientists tend to believe that these unexpected reactions are caused by a lack of knowledge on the part of the public and that the conflicts can be countered through education (Ahteensuu, 2012). In situations where conflict has appeared, the public have been called passive (see Bucchi, 2008) or indifferent (Bodmer, 1985) for not informing themselves about the relevant technology. We argue that this does not do justice to the public. People simply do not have the time to study all the innovations they may encounter, as we argue in more detail later.

In the current article, we investigate how people give meaning to an unfamiliar technology about which they have no knowledge other than the name, and the way this process is influenced by the name of the technology. We argue that different names can cause different inferences to be created, influencing the way people interpret a technology. Whereas one name might assist useful interpretation, another name might cause interpretations using concepts that are irrelevant.

Although there will be some attention to the effects of a name on the possible processing of information when it is available, the main focus of this article will be on responses triggered by just the name of a technology. As such, we depart from the dominant approach in science communication where the effects of provided information are investigated (Bos, Koolstra, & Willems, 2009) and influences of cognitive mechanisms such as framing, (re)coding and the elaboration likelihood model on the interpretation of information is investigated.

We want to stress that it is not the aim of this article to promote merely choosing a nicer sounding name. The aim is to investigate the development of knowledge and its effects on attitudes and the way this is influenced by a name, so that we can have a deeper understanding of the process – an understanding which can help narrow the communication gap between experts and the public. We conclude that science communication can benefit from an approach in which the development of a name becomes a process of co-creation between science and society. We begin by presenting a reflection on science communication from a cognitive perspective, to highlight where we believe a lacuna exists.

History of understanding and attitudes from a cognitive perspective

In 1985, the report entitled *The Public Understanding of Science* was published (Bodmer, 1985). The report was initiated because of the increasing public scepticism about science and technology (Gregory & Lock, 2008). According to the authors, the negative attitudes towards science and technology were the result of a lack of understanding. Providing people with knowledge through education would solve the problem.

The idea that education solves negative attitudes is now largely rejected in the field of science communication (Ahteensuu, 2012). From the current perspective, we identify two groups of issues with the educational model. The first group relates to the role of information in decision making. The second group relates to the political motives behind the report. Both groups have led to developments which still influence the research agenda today and have caused and maintained a void in studying public understanding that we are now trying to fill.

With respect to the first group of issues, the model reasons from the classical economic 'rational man' perspective, in which it was presumed that people carefully use all information available to them. A problem with this perspective is that it is not equipped to explain much of human behaviour, and this inspired the development of new insights. In communication, dual process theories on attitude formation (Chaiken, 1980; Petty & Cacioppo, 1986) have been developed to explain behaviours that could not be explained by the rational man paradigm. According to these models, there are two ways to process information. The first is a systematic way, where all information is elaborated on carefully and which fits the rational man paradigm. The other is a heuristic way, where information is processed quickly and without too much effort. People use the heuristic way for different reasons, among other things because they are not able to devote enough attention to the information – a common event in noisy daily life.

Dual process theories make an important contribution to understanding human decision making. However, they are still about processing externally provided information (Bargh, 2002). Much of the attitude formation that takes place in daily life happens without the processing of externally provided information, either because the information is not available on the spot or because daily life offers too much distraction for a person to pay any attention. In conclusion, dual process theories do not account for all possible ways of evaluating. They cannot be applied to explaining attitude formation without external information.

The idea that people form their behaviours without information was successfully advocated by Simon (1979) when he introduced the notion of bounded rationality. According to Simon, when they have to make a decision in daily life, people do not search extensively for all available information. Rather, they use the information currently available to them to make the decision. Whereas dual process theories are about information processing, bounded rationality is about information searching.

With respect to the second set of issues, the political issues, it can be argued that the educational model has given rise to a type of reasoning by technical experts that has led to more conflict with the public. According to Bucchi (2008), members of the public have been called ignorant and lazy for not getting the knowledge that would make them change their opinion, in an attempt to disqualify them from the debate.

Unfortunately, excluding the public because they are ignorant blocks the development of insights into the role that ignorance plays in decision making and attitude formation. From the example where respondents were asked to react to the relatively unfamiliar concept of genomics (van Dam & de Vriend, 2002), we can learn that people often do decide and evaluate without knowledge, being ignorant. Within the interaction between the researcher asking about genomics and the respondents, there was no information on genomics available for processing, nor was there familiarity with the concept. Nevertheless, people reacted to the questions. These kinds of behaviours take place in an absence of understanding (or an absence of information, other than the name, to be processed to reach understanding).

Although people are often forced to make decisions without, or before they have, any knowledge about a technology, most research investigates people's reaction to information about a technology rather than tests behaviours without knowledge. A notable exception is provided in a study of the *ecogenomics* construct (Bos, Koolstra, & Willems, 2009). The goal of the study was to ascertain the amount of information people were planning to try to obtain. Although the respondents reported that they planned to search for information, the amount of this information was very little and far from enough to reach a deeper understanding.

In defence of the Bodmer report, it should be noted that the report argues that public misunderstanding or ignorance can lead to issues in daily life. Even though this may be motivated by political goals, the authors do have a point when they argue that little or no knowledge can lead to misunderstanding. Many technical experts still adhere to the educational model (Ahteensuu 2012), and a possible contributory factor is that they notice that people really do not understand. Given the results in Bos et al.'s (2009) study, it actually would be surprising if the respondents were able to form a proper understanding with the small amount of planned information search.

The respondents' behaviour becomes understandable when we place it in the greater context of daily life. If people always searched for enough information to reach understanding when they encounter new concepts, they would spend all their time being educated. People have no choice but to act on little information. Rather than try to correct people's knowledge level, an attempt can be made to account for the way people form their daily understanding. If the process is understood, people could be influenced not to draw inappropriate conclusions and be steered to more appropriate impressions.

A good example of how this might work is provided by the effects of the expressions *global warming* and *climate change*. Some technical experts use the term climate change because it is more appropriate from a technical perspective (Conway, 2008). However, with the aim of changing people's behaviour in daily life, the term global warming might be more efficient. Research has shown that people link global warming more to melting icebergs and glaciers, and the melting is more often believed to be the result of human behaviour (Whitmarsh, 2009). Without people fully understanding the complexities of the global climate, global warming triggers the right ideas.

We argue that a better understanding of attitude formation and decision making without information can lead to a more effective way of communicating. Instead of trying to educate the public, technical experts should recognize that daily understanding is a different form of understanding. By explaining how public understanding differs from expert understanding, certain interpretations can be prevented and other interpretations can be enhanced by steering people in the right direction. To be able to do this, we have to understand the differences in the way people and technical experts organize their knowledge, and the way a name representing a technology activates knowledge.

Understanding new concepts

To understand how human decision making functions, we have to understand how knowledge is organized. A theory that describes this is categorization theory. According to categorization theory, concepts are organized in categories. For example, we have a category for cars, doors and cats, respectively. A category is structured based on the common features of its members (Rosch, 1978), and therefore a category contains concepts that are similar in some ways (Loken, Barsalou, & Joiner, 2008). Schemata are interconnected categories. A schema of categories is a taxonomic description of the way someone's knowledge is organized. Categories enable us to use our knowledge efficiently. For example, instead of remembering for each and every cat that it has four paws and a tail, it is enough to remember that, in principle, cats have four paws and a tail.

The usage of categories can in addition help us to understand new unfamiliar concepts (Gregan-Paxton & John, 1997; Loken et al., 2008). The notion is that, when people are confronted with new concepts with which they are completely unfamiliar, they study the concept and try to match it with similar concepts they already know. This process is called categorization, which can be defined as placing a new concept in an existing category. Through this act, knowledge about the known category members can be used to interpret the unfamiliar concept.

With categorization, people learn about new concepts through an internal transfer of knowledge. Knowledge about known concepts is transferred to the new concepts. In this respect, it can be considered as an alternative to education, where information is provided externally. When confronted with new concepts, people will first try internal transfer to understand the new concepts (Michaut, 2004). The process enables people to quickly form an understanding without the use of any external resources, and therefore with no information search.

Related to the transference of knowledge is the process of attitude extension (Muthukrishnan & Weitz, 1991). When attitude extension takes places, the existing attitudes of the known category members are extended to the new concept. In a way, this process serves as a shortcut to forming attitudes without getting knowledge or education. Because of attitude extension, people can project their existing attitudes about familiar concepts onto concepts about which they have no knowledge. It enables them to make quick decisions without knowledge and carry on with their everyday tasks.

The process of attitude extension provides an explanation about where initial attitudes towards science and technology originate. For example, it has been found that a lack of knowledge does not block the formation of attitudes towards genetic modification (Frewer, Shepherd, & Sparks, 1994). Attitude extension can account for this process. Attitudes from other, known agricultural technologies, or even other acts of manipulation, can be used to form an attitude about the new technology. Instead of evaluating the new technology using its own attributes, attitudes are copied from other concepts.

A proper way to describe these attitudes is prejudice. Nowadays, the term *prejudice* is virtually exclusively linked to social prejudice; however, prejudice can also relate to concepts. When social prejudice occurs, members of a social category are judged on the attitudes relating to the category to which they belong. When genomics is judged by applying attitudes about genetic manipulation because they are believed to belong to a shared conceptual category, conceptual prejudice occurs. One problem with prejudice is that it is very hard to eradicate. An important reason is that it steers interpretations of new information towards a person's existing preconceptions.

To prevent inappropriate attitudes from being copied and related prejudice from being formed, the challenge is to anticipate which attitudes will be used for the process. To achieve this, a focus on the activation of categories that are linked to the attitudes is needed, and a focus on how the public's category structures are different from those of technical experts. It is necessary to understand the difference between technical experts and the public because the difference in structures may lead to unexpected activation of categories and related attitudes on both sides in communication.

Categories can be divided into subcategories containing more detailed information or combined into super categories containing more abstract information (Rosch, 1978). In addition, categories can be linked to other categories or concepts. As already discussed, schemata are the resulting networks of categories. For many of these categories or schemata, we have a name or term to represent them (Rosch, 1978). When communicating with others, we try to activate these schemata in the mind of the receiver by using the name or term. What the name activates depends to a very large extent on the knowledge present in the receiver. To illustrate, the term *gen* will not mean anything to someone who has absolutely no knowledge about it. On the other hand, it might activate knowledge relating to genetic manipulation for someone who has encountered the term in public debates on genetic manipulation. For an expert, it could mean activation of an extensive schema about heredity. For this expert, genetic manipulation might not be activated directly, because it is regarded by this person as a separate construct. Clearly, expertise is an important factor which determines the sources of knowledge that are activated. To investigate this more precisely, we turn to the topic of how schemata are influenced by expertise.

Expertise

Expertise is regarded as an important factor in categorization (Alba & Hutchinson, 1987). As already stated, different categories can be linked to one another directly or through super categories, and can be divided into subcategories. Compared to non-experts, experts have more elaborate and flexible cognitive structures (Alba & Hutchinson, 1987). Therefore, the categorization process can differ greatly between experts and people with less knowledge. To understand how these differences may act out, we discuss the main differences.

Compared to non-experts, experts know more attributes (Alba & Hutchinson, 1987). This enables an expert to create a greater number of subcategories than non-experts. Whereas experts and non-experts might both see a laptop when confronted with a MacBook, only the expert will know the attributes that set the MacBook apart from prototypical laptops. In essence, the expert has access to a subcategory that contains extra information. Because they know more, experts can categorize not only more accurately, but also more appropriately. For example, a non-expert might inappropriately categorize a computer screen in the category *televisions*. To understand the difference between a computer screen and a television, a person has to know what a tuner is and use the invisible attribute to divide the concepts into different groups.

Within categorization theory, a differentiation exists between natural categories and abstract categories. Natural categories are categories that people form automatically (Rosch, 1978). Abstract categories are transferred through education (Alba & Hutchinson, 1987). A good example might be the category *night shade*, to which both the tomato and the potato belong. It requires a certain amount of education to know the category night shade, and why its members are combined the way they are. A non-expert might group a tomato with oranges (in a category called fruit) instead of with potatoes, on the basis of everyday experience.

In addition, there are ad hoc categories (Barsalou, 1985). These are created with a particular goal in mind and are formed by focusing on functions or attributes that are relevant within a particular context or with a particular goal in mind. Concepts from different categories that share relevant attributes might end up in an ad hoc category that revolves around these attributes (Barsalou, 1985). For example, in certain cases, petrol can remove paint. It shares this attribute with specialized paint removers. The two concepts might end up together in a category constructed with the goal of finding something to remove paint.

Whereas concepts have only one place in the natural categorization classification, they can be simultaneously part of a number of ad hoc categories. For example, although petrol will be by default a member of the category *fuel*, it can end up in several ad hoc categories because of the different attributes of the concept. Another important thing to note is that ad hoc categories can turn into more permanent goal-related categories when they are used more often (Barsalou, 1991). Goal-related categories have a similar influence in the processing of information as natural classification structures (Barsalou, 1991).

To summarize, experts have both more elaborate structures and a greater number of alternatives to natural categories than non-experts; this enables them to comprehend similarities between different concepts that to non-experts appear unrelated. In consumer behaviour, it has been found that experts tend to use functional attributes for understanding (Gregan-Paxton & John, 1997), whereas non-experts use more superficial cues like shape or appearance. Experts can process information about attributes and relate them to other concepts using commonalities between the concepts. In contrast to experts, not having any knowledge about the attributes that can be used to connect the concepts, non-experts are not able to do this.

If a non-expert will have a harder time making proper connections for categorization, falsifying a categorization will be equally or even more difficult. Imagine a person who does not know the technical and functional aspects of a CD. When this person encounters a DVD for the first time, there is a very good chance that the DVD will be categorized with CDs because they are similar in appearance. When a person knows only the superficial features, it is impossible to realize that the categorization is incorrect from a functional perspective. Only knowledge about their respective functional attributes will give the ability to separate the two concepts.

These differences in cognitive structures cause experts to understand more precisely the way new concepts relate to known concepts. An expert with an elaborate understanding of genetic modification, first of all, knows the attributes of the concepts involved. The expert is familiar with attributes like DNA, alleles and genes, and understands how they are related. In addition, the person can separate different approaches such as genetics and genomics. The expert will have the ability to understand that the technology is a new form of reproduction. This realization will enable the expert to position it vis-à-vis other types of reproduction, like sexual reproduction, which in turn is linked to traditional breeding. The reality of genomics-assisted breeding can only be understood using different kinds of schemata.

Whereas experts use functional attributes for understanding, non-experts who do not have the appropriate knowledge about attributes use superficial features for categorization and rely on similarity (Gregan-Paxton & John, 1997). Although experts might need the appearance to sense the object, it is the functional attributes that will be used for categorization. For example, an expert will see the same ignition key of a car as the non-expert but consequently know that it will turn the engine on. Therefore, using the functional attribute, the expert might categorize the concept with switches. A non-expert might look for an object that is similar in appearance, for example a lock, in an attempt to understand the new concept.

An important superficial feature of a technology is the name given to it. When a name is given to a technology, any name can be given. However, when a name is chosen to have meaning, the effect of a name on categorization can be similar to that of other superficial features. A meaningful name acts as a conceptual label (Gregan-Paxton, Hoeffler, & Zhao, 2005). For example, the function of the attribute *door handle* is captured in the name, but will only be noticed by English-speaking people who, in addition, already know about doors and the way they function. So, for people with related knowledge, the name can be a guide to the functional aspects of the attribute (see Rosch, 1978). Without the related knowledge, it can guide people to concepts that are similar in name. When a person is confronted with the, for this person, meaningless term genomics, the nearest concept to use to give meaning is genetic manipulation. Whereas tangible concepts can also steer interpretation by their shape (a door handle ‘invites’ its use), the only detectable feature of an invisible technology is the name. People prefer to give meaning using appearance rather than the conceptual label (Gregan-Paxton et al., 2005), but this is impossible when dealing with abstract technologies. Therefore, a name can be very influential in what people believe a technology to be and in the attitudes that are activated. With this in mind, we can answer the question about the way people give meaning to a technology about which they know nothing.

The effects of a name

Imagine yourself back in the supermarket confronted with the new technology, next gen-radiation. The question is what knowledge you will use to explain to yourself what the technology is. Will the gen part of the name cause you to believe that it has something to do with genetic manipulation, or that it is the next generation of radiation? And what does the term *radiation* remind you of, sunlight, radio waves or ionizing nuclear radiation?

When people try to give meaning to a concept which is communicated by its name, they only have the name to process. The name can determine categorization. By calling a new technology genomics, the name activates meaningful categories for experts. They are given a label that they can use to position the technology vis-à-vis other related technologies, and related knowledge is activated. However, to be able to do this, they need knowledge of these technologies. For non-experts, on the other hand, the term is relatively meaningless and does not guide to a proper categorization. For them, the only effect will be that the genomics concept sounds related to the genetic modification concept. From a learning perspective, the name is unintentionally activating genetic modification as the only available association.

A name can activate knowledge or attitudes other than those intended. Although experts might argue that these are not the right knowledge or attitudes, this knowledge and these attitudes will not be without consequences. People can still make decisions about buying products or supporting a technology using their activated knowledge and attitudes, even if these are linked to irrelevant concepts.

Scientific notions and technologies that are distinctively different according to experts might therefore be experienced as similar by non-experts. This can cause the public to react in a way that is not expected by experts. Attitude extension from genetic manipulation to genomics leads to a negative reaction that might be surprising for experts. Whereas experts feel that they are doing something fundamentally different, or even trying to find a solution for the objections against genetic manipulation by pursuing an alternative which provides similar advantages, the public experience the two as the same thing because they lack the knowledge about the attributes that set the two apart.

Using inappropriate knowledge does not necessarily mean that people will quickly become stuck during processing and understand what is wrong even when additional information is provided. Even though people have activated inappropriate knowledge, the processing of the information can go a long way without the error being noticed. A nice illustration of this is a journalist who reported on the preparation to form the Dutch genomics centre. In his newspaper article, he noted – presumably after having studied the subject – that the centre for genomics was investigating '… genetic modification of both the tomato and the potato…' (Janssen, 2002: 10). In the case of genomics and genetic modification, both technologies claim to produce more crops, reduce pesticide use, provide opportunities to produce food in harsh conditions, etc. When more affective attitudes, rather than knowledge, are used to make decisions, it is even harder to notice that they are based on inappropriate information.

An important contributor to not realizing the differences between a new and a familiar concept is selective attention. A name acts as a label guiding people to a particular schema, which in turn acts as a frame when processing information (Ferguson & Bargh, 2004; Herr, 1986; Higgins, 1996). Once this schema becomes activated, people pay more attention to the attributes that are part of the schema, disregarding those that are not (Rajagopal & Burnkrant, 2009), which also determines what people will remember (Sedikides & Skowronski, 1991). Ironically, these might be the distinguishing attributes that define the newness of the concept. Therefore, even in the few cases where members of the public receive education, the effect of the name can influence the development of the knowledge. In particular, when a new concept is placed close to a related and very similar concept, for example by name, there is an increased chance that people will not notice the difference (Gregan-Paxton & John, 1997). Instead of building a new schema, all new information might be connected to the one that has been activated. In the case of genomics, very little applies to genetic manipulation that does not also apply to genomics, and vice versa.

Because experts rely more on functional attributes when they give meaning to a new concept, they more quickly realize the uniqueness of a new concept. For example, genomics can be understood by noticing that the technology shares attributes with both genetic manipulation and traditional breeding. To be able to position the technology within existing knowledge, an expert will create a new schema. Non-experts do not combine knowledge from different sources using attributes the way experts do. Therefore, they do not notice the differences between the new concept and the concept used to give meaning, and consequently do not notice that a single known concept is not enough to understand the new concept. The result is that non-experts learn from single examples (Gregan-Paxton, 2001), leading to exemplar learning (Barsalou, 1991) and single category beliefs (Rajagopal & Burnkrant, 2009). The meaning given to the new concept is basically a copy of what is already known.

To be able to understand what makes genomics a unique concept, a person has to use attributes from different sources. Because of their extensive networks and ability to use attributes to create connections between schemata, experts are able to combine these sources. For non-experts, the problem is that these different sources of relevant knowledge and attitudes are disconnected. A way to combine this knowledge from different sources is described in an approach called learning by analogy (Gentner, 1983; Gregan-Paxton & John, 1997), which we discuss next. This approach argues that consumer learning can be guided by activating categories that might not be appropriate for categorization but nevertheless contain information that can be useful for understanding.

Learning by analogy

Learning by analogy argues that, to understand new concepts, we often need more knowledge than is stored in the category used for categorization (Gregan-Paxton & John, 1997). Many new concepts that we encounter, especially concepts relating to advanced technologies, can only be fully understood by using knowledge from different categories. For example, smartphones might be categorized in the category *phone*. However, trying to understand a smartphone by categorizing it as a phone will only activate a subset of relevant knowledge and attitudes. Nowadays, smartphones are best understood as being very small portable computers that, in addition to making calls, can run software and be used to connect to the internet. Activating knowledge and attitudes about computers when a person is trying to understand a smartphone might result in a very different understanding and evaluation.

Essentially, learning by analogy proposes a mechanism to circumvent the limitation of learning using single category inferences. The way to achieve this is to single out attributes that are important to understand the concept and to connect these with attributes of known concepts from different categories. According to the theory, communicators should try to achieve understanding by explaining in what ways a new concept relates to others concepts. This can be achieved by illustrating that a smartphone is like a phone, you can make calls, and it is like a computer, you can run software.

Although leaning by analogy can be used to explain new concepts efficiently, it also provides valuable information about situations in which an explanation cannot be provided and where people are forced to act on a name alone. Basically, learning by analogy focuses on unlocking and activating different knowledge than that which might be activated by categorization to enable understanding. Learning by analogy shares with goal-directed categories the idea that there are alternative structures to natural categories to organize knowledge.

When experts search for a name to describe their new technology, they tend to use a taxonomic classification that emphasizes its position relative to other technologies. The name genomics is no exception. It illustrates the relation to other gene technologies. On the other hand, the main attribute of genomics, applied to plant breeding, is that reproduction is not artificial but natural. Genomics shares this attribute with other ways of breeding, for example traditional breeding where crops are produced using natural sexual reproduction. Choosing a name that emphasizes this important attribute, which distinguishes it from other gene technology, provides an alternative that might be more meaningful to non-experts. To exemplify (without suggesting a change of name), genomics could have been called natural crossing instead, to promote the main attribute differentiating it from genetic manipulation.

Whereas learning by analogy emphasizes the notion that there are alternatives to learning through categorization, we emphasize that there is an alternative to naming a new technology from the perspective of category relations. In situations where people do not have schemata based on relations between abstract concepts, a name that stresses an important attribute might contain more information than a name that illustrates the position of a new technology vis-à-vis related technologies.

The meaning of a scientific name can only be clarified on the basis of a dialogue with a broad range of societal actors. Experts have to focus more on the social, cultural and moral (re)presentation of scientific knowledge and the social structure of technology (Hamlett, 2003, Decker & Ladikas, 2004, Sarewitz, 2004). By acknowledging these, experts and social actors can together co-create a name which is both meaningful to the public through the associations. This also provides the opportunity go beyond the associations being meaningful from a theoretical scientific point of view, but to include more normative or moral associations as well In her comparative political study of biotechnology in the United Kingdom, Europe and North America, Jasanoff (2005) showed, that where public involvement is insufficiently available formally, it will occur informally, through public protest; market choices, such as consumer rejection of genetically modified foods; or new political structures, such as environmental movements. By also including normative or moral associations, the risk escalating mistrust as a result of believing a name is misleading or unjust marketing can be diminished.

Discussion and Conclusion

Nowadays, we are continuously confronted with new scientific and technological developments. It is impossible to get to know all of them. The vast majority of technologies will reach people before they become educated about them, if they ever will. That does not mean that people do not respond when they are confronted with concepts with which they are unfamiliar. By using knowledge and attitudes about what they believe to be similar concepts, people nevertheless judge and make decisions.

It is important to realize that, in situations like these, people do not just act at random or irrationally, even though it might appear this way from the perspective of experts. People are guided by using existing knowledge and attitudes, even though these might be linked to irrelevant concepts. They try to act rationally in a situation where they do not have the appropriate knowledge to do so. To be more precise, non-experts use less extensive schemata to process the information. The important differences between new and familiar concepts can be so subtle that they are not noticed or comprehended; and, even if people notice errors or imperfections in their logic, they still have no alternative.

For invisible technologies in particular, a name can have a severe impact on the interpretation of what it entails and the development of attitudes. Realizing this has several consequences for the development of a proper name. To avoid unnecessary controversies, it is beneficial for experts to anticipate the way non-experts give meaning when confronted with technical names. First, it is important to know that non-experts try to form understanding through internal transfer of knowledge and attitudes. When people are confronted with a new technology, the knowledge and attitudes that they use to assess it will probably come from a single familiar category or example. Experts names should try to guide the consumer to a particular source that holds valuable information. This guidance can be achieved by selecting a name that has value for the public.

Second, it is important to realize that what a name means for experts may not be the same as its meaning for the public. For example, the word gen might be understood completely differently because, in public debates, it is often linked to genetic manipulation. The real scientific meaning might therefore not exist in the minds of many non-experts. From a cognitive perspective, a name might activate unexpected schemata. In order to prevent instant misunderstanding, it is important to test whether or not the name actually activates information that is meaningful for understanding the concept or the main attribute.

When education does take place, people will pay more attention to information that is in line with expectations based on the activated schemata. In a study on the effects of providing information, Scholderer and Frewer (2003) found that providing information about biotechnology did not lead to attitude change, merely to the activation of pre-existing attitudes. The pre-existing attitudes form a judgement without knowledge, or a prejudiced judgement. In a way, people are prejudiced in favour of information that confirms activated beliefs. Activating the proper beliefs by a well-chosen name might enhance the success of an education programme.

A complicating aspect unmentioned so far is that categories and their association with names are not necessarily the same between cultures or stable over time. In some cases, it might be wise to select different names for different languages or cultures. This does not take away the fact that well-chosen names can provide an important advantage. It does mean, however, that deliberate attention to the context can enhance the benefits of selecting a name. In some cases such attention might even be crucial.

Overall, in order to reach the public, it is important not to try to achieve perfect understanding, but rather choose to achieve a good enough understanding. Instead of trying to enforce their own complex schemata on members of the public, scientists should focus on a category that is useful. Many technological names emphasize the relation of a technology to other technologies. The name is given with the extensive organization of other technologies in mind, and the name has meaning within this structure. Without this extensive schema, the name has no meaning. Trying to completely explicate the schema to a non-expert is probably a lost cause.

In the current article, we explored the way people without knowledge give meaning to genomics, with the gen part of the name being the central concept. We believe that the principle can be applied to other fields where people do not have the correct knowledge to differentiate between concepts, and where scientific names might have a different meaning in daily life. For example, nuclear is more associated with radiation than with atom cores, synthetic biology might cause people to believe that this is related to synthetic materials, and the extent to which people can tell the difference between harmful nanoparticles and the broader field of nanotechnology is highly questionable. In situations like these, negative attitudes might appear for invalid reasons and harm the technology purely due to misunderstanding. Wrong interpretations can cause unnecessary confusion and even cloud ethical debates.

It should be noted that we are in no way trying to argue that people in general are ignorant and that their opinions should not be respected, or that providing education is necessarily a bad thing. We do say that it is impossible to be educated and knowledgeable on everything. It is therefore, in our opinion, neither fair nor realistic to expect people to know everything, and not to accept public opinions based on imperfections of understanding. We have to accept that people are forced to use inferences and that, when education does take place, the development of knowledge can be influenced by the inferences made. When new technologies are being introduced, it is necessary to keep in mind everyone's cognitive limitations. Instead of using a lack of knowledge against the public, experts should try to prevent incorrect understandings and try to guide people to meaningful knowledge. We want to stress that we do not suggest that experts should just pick a nicer sounding name. The suggestion that experts should investigate what kind of name creates meaningful inferences is meant to enhance understanding and prevent confusion.

It should also be noted that, of course, not all objections towards new technologies are the result of misunderstandings. It is true that it was expected by experts that due to genomics sharing key features of traditional breeding, it would be evaluated more favourably in comparison to GM (Hall, 2010). It is also true that, as stated previously, GM and genomics share features. The current article is, however, based on observations by experts that people confuse technologies due to an (common) absence of knowledge (Nap, Jacobs, Gremmen, & Stiekema, 2002; van Dam & de Vriend, 2002), rather than not accept them. In the case of genomics, the technology that can have far-fetching consequences and people that have related knowledge can have well-reasoned arguments. These arguments and the people that have them do deserve attention. We do not wish to argue that genomics is –or should be- regarded as safe, acceptable or ethical. The problem we are addressing is the fact that people automatically assume that genomics is GM., which is neither correct nor a normative issue. Our interest in ignorance is in no way support for dismissing genuine concerns as resulting from a lack of knowledge.

In clouded debates, it is especially easy to see that there is a logic behind the idea that the public need to be educated, even though this idea is often disregarded due to the false belief that education equals persuasion. It should be noted that the idea of educating the public has not been developed only from the observation that people disagree; another important part is the observation that people, on occasion, do have misconceptions. The introduction of new technologies in society can definitely be harmed by a lack of understanding. Education could possible reverse this. Unfortunately, it would require too much education, on too many occasions and in unsuitable situations. Instead of trying to reach the public with external information, experts should try to utilize existing internal knowledge of members of the public. It is our advice to select names through a process of co-creation, in which not only public associations can be explored, but that give the opportunity to select associations which are deemed important by the public. To increase understanding, the right name can be a powerful tool.

Genomics? That is probably GM. The effects of a name on the interpretation of a technology

This chapter is based on: Boersma, R., Renes, R. J., Gremmen, B., & Van Woerkum, C. M. J. (2011). Categorisatie en vergelijking: De eerste indrukken van een nieuwe technologie. *Jaarboek Sociale Psychologie 2010*. Groningen, The Netherlands: ASPO Pers.

Abstract

In this article, we follow up on food scientists' findings that people have adverse reactions to foods produced with a new technology after hearing about the new technology. From the reactions, it appears that people use their attitudes to technologies they know to evaluate new technologies and foods produced therewith. Using categorization theory, in this study we have found that the name of the new technology determines which familiar technology is used to evaluate it. Comparison between the technology used for categorization and another familiar technology had a slight influence on the attitude formation process. The influence of attitude formation because of the name of the technology was independent of the level of participants' need for cognitive closure. The results of the experiment show that the name of a food technology can play a very important role in the development of an attitude towards the technology and in the acceptance of foods produced with the technology.

Introduction

Communication about food production entails the risk of creating the wrong impression, and impressions can have a large influence on the acceptance of food. In communicating food science and technology, this risk is particularly apparent, as communication is often one-directional and scientists tend to use technical terms that are difficult for the general public to understand. In modern society, where people do not have time to become engaged with all scientific advancements they encounter, science communication oftentimes does not imply much more than a name. When a name is all the public has, the associations attached to this name might have far-reaching consequences; research focusing on the impact of scientific names is, however, largely lacking. In the current paper, we focus on the consequences of the chosen name of a new food production technology on the public's attitudes towards this technology and the food produced with the technology.

Both technical experts and the science communication community pay only little attention to the way a name of a food production technology can influence the public's acceptance of food products. When a new technology is developed, the name of the technology is hardly ever questioned. Yet, there are expert reports about the public rejecting genomics-assisted breeding and future food products after hearing the name genomics. For example, scientists involved in genomics-accelerated breeding report that, when confronted with the name 'genomics,' people who do not have any knowledge about genomics reject related developments and foods for reasons that apply to genetic manipulation (GM) rather than genomics (Hall, 2010). In van Dam and de Vriend's (2002) report about the public perception of genomics, the researchers believe that people use their knowledge about GM to answer questions about genomics. Scientists involved in nanotechnology believe that people tend to reject nanotechnology in general and foods produced with nanotechnology because the public are especially familiar with harmful nanoparticles and therefore believe that all nanotechnologies are dangerous (Kampers, 2009). Unrelated to food, it similarly has been found that people try to give meaning to a term they do not understand by using a related concept. For example, Ingold and Kurtilla (2000) report about a research project that came close to failing because participants responded to questions relating to climate by talking about the weather.

From the above reports, a pattern emerges where people use a technology they know, and which appears related in name, to respond to an unfamiliar food production technology. By using the knowledge and attitudes relating to the familiar concepts, people can in turn respond to the unfamiliar concepts. If this proposed mechanism is correct, it can explain the above experienced patterns in reactions, and particularly the idea that people use their knowledge about GM to answer question about the relatively unfamiliar genomics.

If people use their knowledge about GM to respond to genomics, this may lead to misconstrued expectations. Genomics (accelerated breeding) can be used to create new food products through natural sexual reproduction. GM applies artificial recombination of genes, which makes the technology highly controversial. When we compare genomics with other technologies, genomics actually applies traditional breeding (TB), i.e. sexual reproduction, when creating new crops. The difference between genomics and TB is that genomics is applied after reproduction to check whether particulate genes are present. From the perspective of reproduction, genomics is better understood when people apply their feelings and beliefs about TB rather than about GM. Ironically, it appears that, because of the name, people actually link genomics with GM when evaluating the technology. It is clear that, with all the controversies surrounding GM, the link that people make between GM and genomics can potentially harm the development of the technology and the acceptance of foods when they reach the consumers.

In the current paper, we test the idea that people use a familiar food production technology that appears related by name to give meaning to a technology with which they are unfamiliar. Using an experiment, we systematically investigate whether or not the process takes place and what the consequences are for emerging attitudes about the unfamiliar concept. We build on the observation that people possibly use knowledge about GM to respond to questions about genomics, and we use genomics as an example of the transfer of meaning from one concept to another.

Three theories in social and cognitive psychology relate in particular to the expected process. Using these theories, we formulate and test hypotheses about how they influence the perception of a technology and related foods. The first theory we investigate is categorization theory (Rosch, 1978), which describes the way people use knowledge about familiar concepts to give meaning to unfamiliar concepts. The theory thus offers an explanation as to why people use their knowledge about GM to evaluate genomics. Second, we turn our attention to comparison effects. Comparison effects relate to categorization theory because knowledge about familiar concepts can be used in different ways to give meaning to unfamiliar concepts (Herr, 1986; Higgins, 1989). The last theory we discuss is the theory of need for cognitive closure (Webster & Kruglanski, 1994), which has the potential to explain individual differences between respondents in how they use categorization to give meaning to new concepts. We apply the theory because of the notion held by some technical experts that 'the public,' who are treated as very uniform, are not putting enough effort into searching for information, and that lack of interest is the cause of the wrong interpretation (Bucchi, 2008). According to this theory, the behaviour of searching for more information is a personal trait. It is possible that the theory does apply to some members of the public, those who are high in need for cognitive closure, whereas people who experience more need for extra information refrain from drawing conclusions on categorization alone.

Categorization theory

A theory widely applied in consumer behaviour to predict the way people react to new products is categorization theory (Loken, Barsalou & Joiner, 2008). According to the theory, people organize their knowledge about the world in clusters of related concepts. For example, a person might have a mental category of cats, computers and tomatoes. Knowledge about these concepts is linked not so much to the members of the category as to the category itself. For example, instead of remembering that each tomato we encounter is red, we remember that tomatoes are usually red.

Although categorization theory mainly describes the way we store and organize knowledge, it can also provide insight into the way we try to give meaning to new concepts (Gregan-Paxton & John, 1997). According to the theory, we try to understand new concepts by finding familiar concepts that are, in some way, similar. For example, when a person encounters a cherry tomato for the first time, this person might judge it to be a special kind of tomato and store the new concept in the category tomatoes. This process is called categorization. After categorization, the person can use knowledge about tomatoes to give meaning to, and make decisions about, the new cherry tomato without being fully educated on the subject.

Additionally, attitudes might be activated. These attitudes might be applied to the new category member alongside knowledge. For example, if a person has negative feelings towards tomatoes, the new cherry tomato will probably be evaluated negatively. This is called attitude extension (Muthukrishnan & Weitz, 1991) and can be described as the extension of an existing attitude about familiar concepts towards a new category member.

It is important to note that attitude extension does not require any knowledge about the new concept itself. Therefore, attitude extension provides a quick way to reach an evaluation without getting to know the new construct. The emerging attitudes are the result of what people believe the new concept is related to, rather than an evaluation of the concept itself.

It has been found that, when people have little knowledge about a subject, the categorization of new, related concepts is strongly influenced by superficial, non-functional attributes of the new concept rather than functional attributes (Gregan-Paxton, 2001; Gregan-Paxton & John, 1997). An important superficial attribute of an unknown concept is the name. A name can act as a conceptual label that guides people to known concepts that can be used to give meaning to the new concept (Gregan-Paxton, Hoeffler & Zhao, 2005). Therefore, it can be very determinant in the selection of the category which will be used for categorization. When people are confronted with the name of an invisible technology of which they have no further knowledge, the only attribute available to them for categorization is the name. For example, when people are confronted with the genomics concept, there is nothing to be studied except for the name. Therefore, especially when people have little knowledge about gen-technologies, the name genomics might quickly be associated with genetic manipulation.

Categorization theory can provide an explanation for the way people make decisions and form initial attitudes about genomics and foods produced with genomics. In the current study, we test the hypothesis that, when people do not have any information about genomics, they use attitude extension from genetic manipulation to form an attitude about genomics because of the similarity in name.

Hypothesis 1a: People use their knowledge and attitudes about genetic manipulation to form a response about genomics.

If the name genomics leads to categorization with genetic manipulation, than another name would have the potential to lead to categorization with other technologies. As mentioned earlier, in genomics, the step in which traits are combined entails natural sexual reproduction. A name stressing this particular component of genomics, for example the (fictional) name 'natural crossing' could, with respect to activating related knowledge, lead to a more appropriate categorization from a technical perspective and consequently a more favourable evaluation of foods produced with the technology. Therefore, we study the response of respondents to the fictional name, natural crossing.

Hypotheses 1b: People use their knowledge and attitudes about TB to form a response towards natural crossing.

Comparison effects

Categorization plays an important role in the way attitudes are influenced by the context, not only through the categorization itself, but also by the way activated categories are used for evaluation (Herr, 1986). Especially when people experience ambiguity towards a concept, attitudes can be influenced by the context in which it is reported (Higgins, 1989). Therefore, attitudes formed and reported can be influenced by the context, particularly in a situation where people try to give meaning to an abstract technology, making the interpretation of genomics susceptible to comparison effects.

When a concept under evaluation is placed within a category, information linked to the category can act as an interpretation frame that can be used to give meaning to the unfamiliar concept (Higgins, 1989). When the presentation context in which the new concept is presented is used for categorization, then the evaluation shifts towards the evaluation of the presentation context. This process is called assimilation. For example, if genomics is presented in a context with GM, and people believe the two are the same, the evaluation of genomics will shift towards the evaluation of GM because the context reminds people of GM attributes, which can, in turn, be used to evaluate genomics.

When a concept is presented in a presentation context which is not regarded as suitable to give meaning to an unfamiliar concept, the presentation context can act as a standard for comparison (Herr, 1986). For example, when genomics is presented in a context with traditional breeding and it is believed that genomics is a form of GM because of categorization by name, people will be inclined to compare genomics with the context. Rather than using the context to give meaning by focusing on (what are believed to be) shared attributes, the person will focus on the presumed differences. Consequently, genomics might be evaluated even more negatively because the evaluator focuses on favourable attributes of TB, which genomics is believed not to have. In addition, when the presentation context is experienced as potentially inappropriate, people might correct their evaluation away from the context to compensate for the influence.

Judged on its technical attributes, genomics might be explained best by comparing it with traditional breeding. Unfortunately, when people already believe that genomics is GM, comparison effects might result in even more unfavourable attitudes if people make this comparison. In the current experiment, we test the hypotheses that the name genomics will lead to an even more negative evaluation when it is combined with the TB concept.

Hypotheses 2a: The name genomics will lead to a more negative evaluation when presented in combination with traditional breeding than when it is presented with GM.

In the current line of reasoning, the name natural crossing can be expected to have an alternative effect. If natural crossing makes people believe that the new technology is related to TB, then it can be expected that the evaluation will assimilate towards TB and contrast away from the evaluation of GM.

Hypotheses 2b: The name natural crossing will lead to a more favourable evaluation when presented in combination with GM than when it is presented with TB.

Need for cognitive closure

An important question in studying public perceptions is the extent to which there are individual differences in relying on categorization when people evaluate a concept or answering questions. It is very possible that some people will rely on categorization and report extreme evaluations, whereas others will refrain from reporting extreme attitudes until they have more certainty that their presumptions are correct.

A theory which describes the process of reaching conclusions through (among other things) categorization and the way this is influenced by individual differences is the theory of need for cognitive closure (Webster & Kruglanski, 1994). According to this theory, people try to understand concepts in two steps when they are confronted with something unfamiliar. First, they try to formulate a preliminary answer. Second, the answer is treated as a hypothesis and tested. After testing, it is either accepted or rejected. Cognitive closure is reached when the answer is accepted.

When people have a high need for cognitive closure, an answer as to what an unfamiliar concept entails is reached faster. The difference is to be found in the second step towards reaching cognitive closure. When the need for cognitive closure is high, people will invest less time in testing whether their initial idea is correct or not, compared to when a low need for cognitive closure is experienced. Essentially, when the need for cognitive closure is high, people are motived to quickly reach a conclusion rather than wait for a fully correct answer.

The need for cognitive closure is considered a personal trait. People who are high in need for closure tend to avoid uncertainty and ambiguity, whereas people who experience a low need for cognitive closure aim to be correct. However, a person might experience a difference in need for cognitive closure. In situations where drawing the wrong conclusion can be costly, the need for cognitive closure might be lower (Kruglanski, Webster & Klem, 1993). When testing an answer is difficult due to time pressure or lack of resources, people might experience an elevated need for closure.

In the current experiment, we study the effects of need for cognitive closure on categorization and attitude extension. We hypothesize that people who experience high need for closure will rely more on categorization and attitude extension when answering questions about genomics or natural crossing.

Hypotheses 3a: When a high need for cognitive closure is experienced, attitudes about genomics are more dependent on attitudes towards GM.

Hypotheses 3b: When a high need for cognitive closure is experienced, attitudes about natural crossing are more dependent on attitudes towards TB.

Method

Participants

In total, 120 students from Wageningen University participated and received a nominal five euros in compensation. The experiment had a 2 (context: genetic manipulation versus traditional breeding) x 2 (name unfamiliar technology: genomics versus natural crossing) design, and participants were randomly distributed.

Procedure

Introduction and manipulation

On entry, participants were welcomed and randomly assigned to a computer. For experimental purposes (see need for closure measurements), they were told that they would participate in a series of experiments and asked to sign a consent form informing them that the results would be processed anonymously and that they could stop at any time if they wished to do so. The experiment began with an introduction presenting a cover story that the aim of the research was to find out how people thought about different ways of making new kinds of fruits and vegetables. The context manipulation then followed, in which a way of making a new cultivar was explained.

Participants in the traditional breeding context read:

"In agriculture, new plant varieties are developed. One way to develop a new variety is traditional breeding. When traditional breeding is applied, pollen from one plant is put on the flower of another. The new plant that will result is a crossing of the 'parents,' and will share characteristics with both of them. For example, a plant bearing many tomatoes and a plant bearing round tomatoes can be crossed to produce a plant bearing many round tomatoes."

Participants in the genetic manipulation context where presented the following text:

"In agriculture, new plant varieties are developed. One way to develop a new variety is genetic manipulation. When genetic manipulation is applied, part of the DNA of one plant is put in the DNA of another. From the new DNA, a plant will develop containing characteristics of both plants. For example, the DNA of a plant bearing many tomatoes can be combined with the DNA of a plant bearing round tomatoes to produce a plant bearing many round tomatoes."

When the continue button was pressed, an extra line appeared on screen presenting the unfamiliar technology. For participants in the genomics context, the following text was added:

"There are more ways of developing new plant varieties. One of them is genomics."

Participants in the natural crossing context were told:

"There are more ways of developing new plant varieties. One of them is natural crossing."

Attitude measurements

After the manipulation, participants rated the unfamiliar context technology on 14 aspects on a 7-point scale adopted from Van den Heuvel, Renes, Van Trijp, Gremmen and van Woerkum (2008). Examples of aspects are the extent to which participants believed that the unfamiliar technology was useful (1 = very useless, 7 = very useful) and safe (1 = very dangerous, 7 = very safe). In order to test the effects on the acceptance of food produced with the technology, the scale was extended with three questions about the actions towards a product produced with the technology and inquired about the extent to which the participant was willing to buy, eat and serve food produced with the unfamiliar technology (1 = absolutely not, 7 = no problem with it), resulting in a total of 17 questions ($\alpha = .94$). Participants were instructed to respond by giving their first impression, and to answer even if they did not know much about the technology. After the unfamiliar technology, the context technology was evaluated (genetic manipulation/traditional breeding) using the same questions ($\alpha = .96$).

Categorization measurements

The categorization measurement followed these questions (see figure 3.1) (Aron, Aron & Smollan, 1992). Participants were confronted with seven pictures. Each picture contained a line on which two circles where placed, and the distance between the circles ranged from full overlap at the middle of the line to the maximum possible distance apart on the line. In one circle, the name of the unfamiliar context technology was presented, in the other, the name of the context technology. For example, participants in the GM/genomics group saw a picture of a circle with the name GM and a circle with the name genomics. Participants were asked to choose the picture that resembled most the way they felt the two technologies where related to each other.

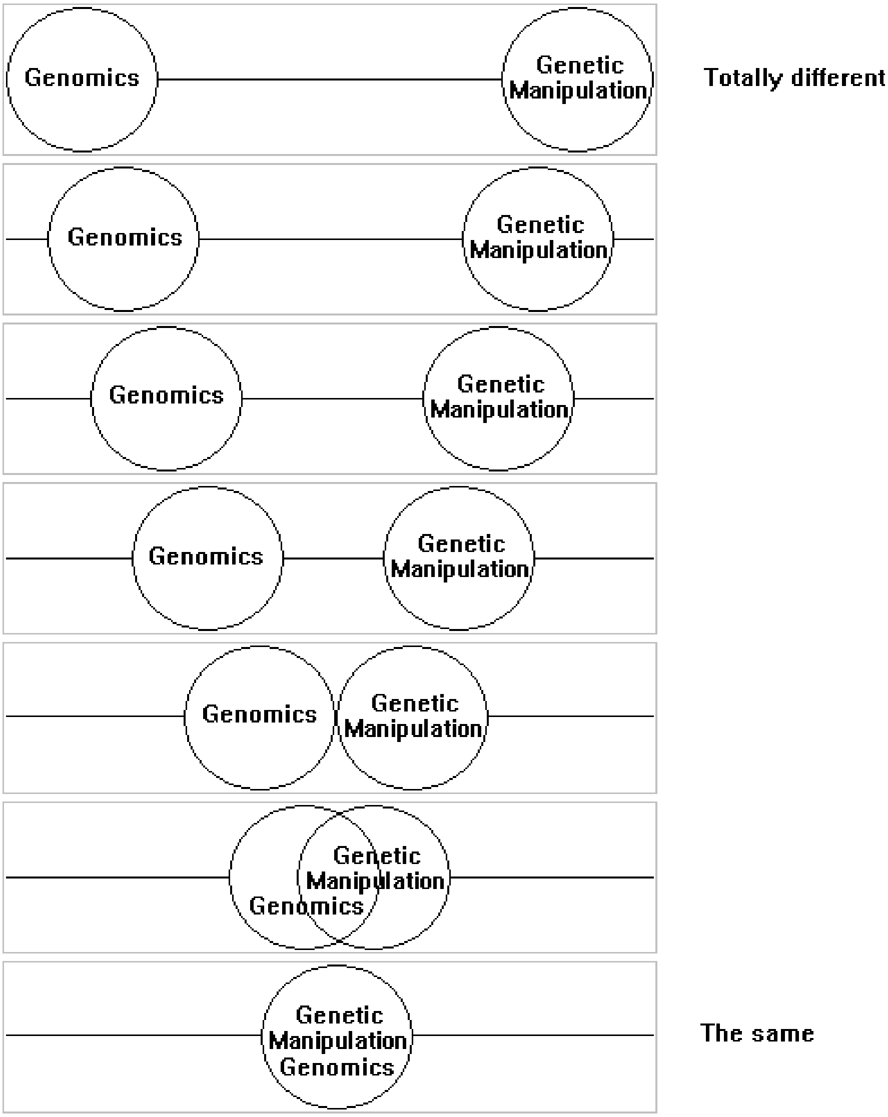

Figure 3.1 Measuring the perceived relation between genomics and genetic manipulation (see Aron, Aron, & Smollan, 1992)

Control variable

The categorization measurements were followed by an open question, in which participants were asked to freely type what they knew about genomics (natural crossing). The answers to this question served as a check to determine whether or not people where familiar with genomics.

Need for closure

After the open question, the need for cognitive closure questions followed. The aim was to measure the personality trait 'need for closure' and to try to minimize the effects of the former questions on the reported need for cognitive closure. In an attempt to achieve this, the participants where led to believe that they were taking part in a new, independent study. To make this convincing, participants were informed that the first study was finished, and they were thanked for their participation. The screen was followed by a new screen asking the participants to answer another short questionnaire about the way they make decisions. Need for cognitive closure was measured using a shortened Dutch version of the questionnaire developed and validated by Vermeir (2003). In total, the participants answered 25 questions ($\alpha = .77$). Examples of the questions presented include: "I want to know immediately what people mean when they say something," "Usually, I take decisions quickly and with confidence" and "When I go shopping I have difficulty deciding what I want" (1 = totally disagree, 7 = totally agree). After this questionnaire, participants were thanked again, and they received the small reward.

Results

Control variable

In the current study, we are interested in the development of emerging attitudes. To be able to investigate the development of emerging attitudes towards genomics, we needed participants who did not have well-established knowledge about, and stable attitudes towards, genomics. We used the responses to the question where participants were asked to write what they knew about genomics to check the extent to which they were familiar with the technology. In total, 58 participants were subject to the genomics context.

Of the 58 participants, one participant gave an answer showing knowledge about genomics, but the answer also included elements of GM. Because attributes of both technologies were used, it was not clear to what extent the difference was understood and therefore the participant remained included in the analyses. Of the remaining participants, three mentioned aspects of genomics, but expressed doubt about what the concept entails. These participants were included because, by showing ambiguity, they met the criteria of not having clear knowledge. The remaining 54 participant did not show knowledge of genomics, with the result that all participants were included in the analyses.

Categorization and attitude extension

Using the graphical categorization question (figure 3.1), we set out to determine the extent to which participants related the unfamiliar technology with the familiar technology about which they read an explanation. The expectation was that participants would believe genomics to be related to genetic modification and different than traditional breeding. When confronted with the name natural crossing, we expected participants to believe the concept to be related to traditional breeding and to be different than genetic manipulation. A 2 (context) x 2 (name technology) ANOVA revealed a significant interaction effect, $F(1, 116) = 71.63$, $p < .001$, $\eta_p^2 = .38$. Simple effect analyses revealed that, within the traditional breeding context, the distance between the context and natural crossing was perceived as smaller, $M = 2.73$, $SD = 0.83$, and the distance from genomics was perceived as larger, $M = 4.38$, $SD = 1.43$, $F(1, 116) = 26.46$, $p < .001$. In the genetic manipulation context, the opposite effect was observed. Here, the distance between genomics and the context was regarded as smaller, $M = 2.69$, $SD = 0.97$, and the distance between natural crossing and the context was perceived as larger, $M = 4.84$, $SD = 1.53$, $F(1, 116) = 46.76$, $p < .001$. The results thus confirm our expectation. Genomics resulted in a strong association with genetic manipulation and not with traditional breeding. The name natural crossing resulted in the technology being closely related to traditional breeding and not to genetic manipulation.

With respect to attitude extension, the hypothesis was that the attitude towards familiar technologies would be used to form an initial attitude towards the unfamiliar technology. A scatter plot (figure 3.2) revealed the expected patterns, showing a clear relation between attitudes to genomics and GM and between natural crossing and TB. Linear regression revealed a significant correlation between the reported attitudes about genomics and genetic manipulation, B = .73, 95% CI [.62, .83], $t(27) = 14.16$, $p < .001$, with the attitudes to genetic manipulation predicting a large portion of the variance of the reported attitudes about genomics, $R^2 = .88$, $F(1, 27) = 200.54$, $p < .001$. The result was similar for the attitudes about natural crossing and traditional breeding, B = .68, 95% CI [.49, .87], $t(28) = 7.26$, $p < .001$, $R^2 = .65$, $F(1, 28) = 52.78$, $p < .001$. Following expectations, the results indicate that the attitude towards the unfamiliar technology is derived from the attitude towards the familiar technology with which people categorize the technology. There is a strong correlation between the attitudes towards genomics and the attitudes towards GM, and a strong correlation between the attitudes towards natural crossing and the attitudes towards TB.

The scatter plot does not show a relation between the evaluations of genomics and TB or natural crossing and GM. Linear regression did not reveal a relation between the attitudes about genomics and traditional breeding either, B = .18, 95% CI [-.26, .61], $t(27) = .83$, $p = .42$, or between attitudes about natural crossing and genetic manipulation, B = .07, 95% CI [-.15, .29], $t(30) = 64$, $p = .53$. These results confirm that the relation between the attitude towards the unfamiliar technology and the context technology only exists for the combinations where the context is considered appropriate for categorization.

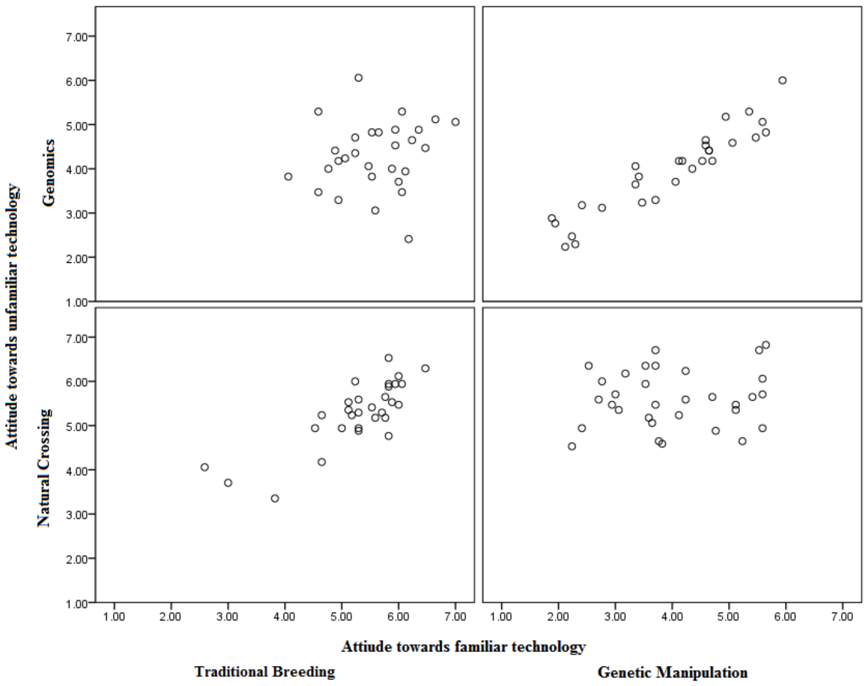

Figure 3.2 The relation between the attitudes towards resp. Classical Breeding and Genetic Manipulation and the initial attitudes towards resp. Genomics and Natural Crossing

Comparison effects

Whereas attitude extension is concerned about the source of the attitude, comparison effect relates the extent to which the attitude extension is influenced by the context. With respect to comparison effects, the main question is the extent to which the evaluation of the unfamiliar is influenced by the technologies after which it is presented. The presumption is that the attitudes towards the familiar technology presented in the context (GM or TB, respectively) are stable and have an influence on the attitude towards the unfamiliar technology. To exclude the possibility of the attitudes towards GM or TB being influenced by the unfamiliar technology, we apply an ANOVA to see if there are significant differences in evaluation of GM or TB depending on the unfamiliar technology with which it is presented. A 2 (context) x 2 (name technology) ANOVA of the average context scores revealed only a significant main effect of context, $F(1, 116) = 61.39$, $p < .001$, $\eta_p^2 = .35$, indicating that the evaluation of the familiar technology was not influenced by the unfamiliar technology with which it was presented. Genetic manipulation was regarded more negatively, $M = 4.00$, $SD = 1.13$, than traditional breeding, $M = 5.43$, $SD = 0.80$. These average evaluations of the familiar technologies enable us to study the direction of the comparison effects.

We expected that, in the conditions where genetic manipulation was presented as the context technology, the emerging attitudes about genomics would assimilate in the direction of genetic manipulation, and the emerging attitudes about natural crossing would contrast away from genetic manipulation. A 2 (context) x 2 (name technology) ANOVA (see figure 3.3) revealed a main effect due to name, $F(1, 116) = 84.62$, $p < .001$, $\eta_p^2 = .42$. The name genomics caused a more negative attitude than the name natural crossing. Also, a significant interaction effect was observed, $F(1, 116) = 5.46$, $p < .05$, $\eta_p^2 = .05$, showing that the resulting attitudes were influences by the context. Simple effect analysis showed a trend in the difference in appreciation for genomics between the different contexts, with genomics being regarded as less negative when it was presented in a context with traditional breeding, $M = 4.30$, $SD = 0.77$, than when it was presented in a genetic manipulation context, $M = 3.97$, $SD = 0.96$, $F(1, 116) = 2.72$, $p = .10$. When these attitudes scores are compared to the attitude scores for traditional breeding and genetic manipulation, we see that the attitude score of genomics is nearly identical to that of genetic manipulation when they are presented together. When genomics was presented in combination with traditional breeding, genomics was evaluated more favourably than when it was presented in combination with genetic manipulation. As traditional breeding is evaluated more favourably than genetic manipulation, we can conclude that the evaluation of genomics assimilated towards the evaluation of traditional breeding. This leads to a rejection of hypothesis 2a, since we expected a contrast effect. Nevertheless, although in a different direction, comparison effects did occur.

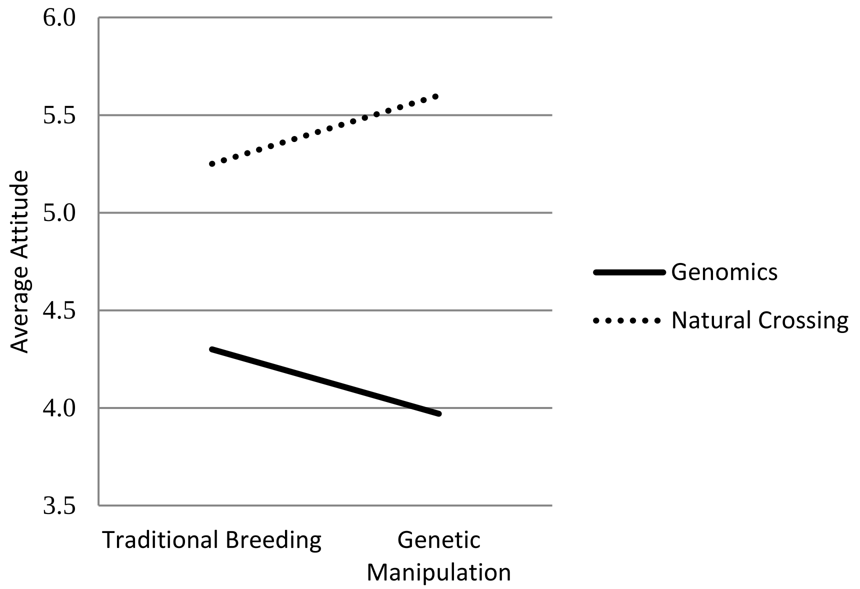

Figure 3.3 The average attitudes towards resp. Genomics and Natural Crossing when being presented in combination with resp. Classical Breeding and Genetic Manipulation

When the name natural crossing was used, the opposite effect was observed, with a better appreciation when the name was presented in the context with genetic manipulation, M = 5.60, SD = 0.65, than in the traditional breeding context, M = 5.25, SD = 0.73, $F(1, 116) = 3.46$, p = .065. Genetic manipulation was evaluated less favourably than traditional breeding, yet the evaluation of natural crossing was higher when it was presented with genetic manipulation than when it is presented with traditional breeding. Therefore, confirming hypothesis 2b, we can conclude that the evaluation of natural crossing contrasts away from the evaluation of genetic manipulation when both technologies are presented together.

Need for closure

The influence of need for cognitive closure was tested for the groups where the attitudes towards the context where expected to determine the attitudes towards the unfamiliar technology. These were the groups that were either presented with the combination of GM and genomics or with traditional breeding and natural crossing. The expectation was that people with a high need for closure would report more equal attitudes between genomics and GM. To test the hypotheses, first the absolute difference between the score on the scale measuring attitude towards genomics and the score on the scale measuring attitude towards GM was calculated. A linear regression that tested the relationship between absolute difference and the need for closure did not reveal a relation, B= -.56, 95% CI [-.25, .14], $t(27) = .60$, $p = .56$. Using the same method, we found no relation between the absolute differences between traditional breeding and natural crossing with need for closure, $B = -.09$, 95% CI [-.29, .11], $t(28) = .90$, $p = .37$. Therefore, it cannot be concluded that need for closure had any effect on attitude extension. Both hypotheses stating that need for closure has an effect on attitude extension are rejected.

Discussion

So far, little attention has been given to the effects that a name can have on the interpretation of a food production technology. Most research on technologies investigates the way people react to a technology after they receive information (Bos, Koolstra & Willems, 2009). However, as indicated by the experiences of experts working on plant breeding for food, it appears that the beliefs and attitudes about a technology may be influenced by the name alone, without additional information. In the current paper, we have investigated the effects of a technology's name on emerging attitudes. Building on categorization theory, we expected that the emerging attitudes of a new technology and related food products could be predicted by identifying attitudes about a familiar technology with a similar name. In addition, we expected comparison effects due to the combination of the name given to a technology and the presentation context. Further, we investigated the possible moderating role of need for cognitive closure.

The current study has shown that the name of an unfamiliar technology can determine the attitude towards the technology. Reported attitudes about genomics were virtually identical to the reported attitudes about GM, and the reported attitudes about natural crossing were very close to the reported attitudes about traditional breeding. The answers to the open question show that this is not due to knowledge about the unfamiliar technology, as the vast majority of respondents indicated that they were not familiar with genomics or natural crossing. Therefore it can be concluded that the attitudes towards the unfamiliar technologies are formed through attitude extension.

In addition, comparison effects had an influence on the evaluations. The evaluations of both genomics and natural crossing were influenced by the technology with which they were presented, although in a different direction. Genomics was evaluated more favourably when it was presented with traditional breeding than when it was presented with genetic manipulation. Natural crossing, on the other hand, was evaluated more favourably when it was presented with genetic manipulation. Several conclusions can be drawn from the pattern found.

When we compare the effect of changing the familiar context technology with the effects of the name of the technology, it can be concluded that the name influences perceptions more than the familiar technology presented in the context. Whereas the name natural crossing systematically led to more favourable attitudes and more acceptance of food than the name genomics, the differences in evaluations caused by the familiar technology caused only minor variations. We can therefore conclude that the differences in evaluations are primarily caused by categorization and extension, with comparison effects influencing the attitudes only to a small extent.

The results did not support our expectation that people who are naturally high in need for cognitive closure would rely more on their attitudes about similar technologies to form or report attitude. A probable cause for failure to find the relation might be the experimental design. Time and information restraints are identified as elements that cause a temporary elevated need for cognitive closure (Webster & Kruglanski, 1994). It is possible that even people who do not normally have a personal high need for closure experienced a high need for closure during their participation in the experiment. Within the current experimental design, it cannot be established to what extent the participants actually experienced an elevated need for closure. The experiment was explicitly designed to prevent a carry-over effect and measure people's personal need for cognitive closure rather than a need for closure resulting from the attitude questionnaire. To conclude, more research is necessary to determine the extent to which need for closure might have an influence on attitude extension. However, we can conclude that when participants are answering questions, such as a public perception report, personal need for closure might not influence the answers given.

The results show that genomics is evaluated more favourably when presented in a context with traditional breeding. This find was unexpected, since we expected that genomics would be evaluated more favourably when presented in combination with genetic manipulation. We expected contrast to prevail due to the reported confusion between GM and genomics. We presumed that, if GM and genomics were regarded as being the same, it would logically follow that the comparison between traditional breeding and genomics would lead to contrast. However, an important determinant of comparison effects is the ambiguity experienced towards the concepts of evaluation (Higgins, 1989). The prevalence of assimilation points to the possibility that, even though people report very similar attitudes towards GM and genomics, they might experience uncertainty about whether they are identical. This uncertainty leaves room for the influence of the presentation context to give meaning, rather than to cause comparison. In general, we would recommend testing the effects of different familiar technologies that could possibly be used to explain the interpretation of an unfamiliar technology. With respect to explaining the current genomics case, the result shows that more favourable attitudes to genomics might be attained not by explaining its difference from GM, but by explaining how it relates to traditional breeding. Unfortunately, this might be very difficult to achieve, because people automatically link genomics to GM by categorization and tend to bring GM into the discussion even when it is not present (Hall, 2010).

In the experiment, we forced people to give an evaluation about technologies with which they were not familiar. The current experiment could be criticized for lacking an 'I don't know' option. The reason for not including such a response option is that, when someone is confronted with a food produced with an unknown technology in real life in a situation that forces an evaluation, there is no escape from making the evaluation. For example, someone might be forced to choose between a regular and a genomics tomato in the middle of a supermarket. This research shows that, in such situations, people can form an evaluation. With all participants showing the same strategy, it can be concluded that the evaluation was more than just a random guess, different from person to person and therefore unpredictable. From the current results, it appears to be a universal strategy that can be predicted.

Critics might argue that people who believe genomics and genetic modification to be strongly associated are actually right. There are many features that make it viable to cluster the two together, such as using information about genes for breeding and issues with intellectual properties. Although these are valid points, categorizing the technologies together on the basis of these attributes requires knowledge about both. The majority of the respondents explicitly stated that they associated them purely by name, and, with the exception of one, no respondent demonstrated detailed knowledge. In addition, it has been found that knowledge about GM is generally very low (Frewer, Shepherd & Sparks, 1994). More importantly, there are a number of attributes that genomics and traditional breeding share that makes it viable to categorize them together. The point is that, when people do not know anything about a technology, the name will determine the categorization, and the name will be the primary element in determining which category will be used when there are several potential categories. The category used then determines the evaluation of the technology and food produced using that technology (Ferguson & Bargh, 2004).

Implications

This research has several implications. First, at the food production development stage, experts should understand the full impact that a name can have on the acceptance of the technology and the related food. This study shows that a name is not a meaningless characteristic. Rather, it is a label which steers interpretations and which is an important – in some cases even the primary – element in shaping initial attitudes towards new food products. Experts tend to choose names that are only meaningful for people who have the necessary expertise. Unfortunately, without this expertise, a name can cause beliefs and attitudes that are unexpected or even believed to be improper by experts. Therefore, we recommend that experts should focus on developing names that can aid in giving a more proper interpretation even if the name will have to be processed without expert knowledge.

Many experts still adhere to the deficit model and believe that these primary attitudes can be corrected with education (Ahteensuu, 2012). Unfortunately, often only a small audience will be reached through public communication. Even more importantly, a wide variety of research has proved that attitudes – including attitudes towards a food production technology (Scholderer & Frewer, 2003) – once formed are hard to change. From a psychological perspective, the main problem is the presumption that attitudes are the result of evaluations and knowledge rather than the other way around. Attitudes act as a perceptual filter that determines which information is accepted, processed and remembered. Instead of the attitudes being altered by information, people use their feelings towards certain foods to determine which information they accept. The result is that attitudes persist, often beyond expectations.

The results have implications also for researchers on food acceptance. Researchers should be aware that answers given or attitudes reported might not be the result of knowledge about the subject. Although results might appear to be an indicator of what people believe about a food production technology, people might actually be reporting beliefs or attitudes about a different concept. Results might properly reflect answers given, but not the core values behind the answers. An answer that shows a rejection of genomics might actually be an answer rejecting genetic modification. Even worse, the respondent might actually have supported genomics if he/she knew the fundamental difference between the technologies.

Conclusion

In this experiment, we tested the extent to which people are influenced by the name of a food production technology alone. The main result is that people unanimously use their attitudes about a familiar technology (GM) to formulate answers about the unfamiliar technology (genomics). The extent to which these new attitudes can affect the interpretation of new information is an important topic for further research. If the new attitudes have an effect on the interpretation of new information, the consequences of a poorly chosen name might even go beyond the current findings. With respect to the current experiment, it can already be concluded that a poorly chosen name might damage the successful introduction of a new technology or food product and that the name of a new technology deserves careful planning. Because of the name alone, consumers might refuse to accept genomics and foods produced with the technology because they believe genomics to be similar to GM. We can therefore conclude that a poorly chosen name is enough to ruin anybody's appetite.

The effects of the name “genomics” on emerging attitudes in the Netherlands and Ukraine

Based on: Boersma, R., Renes, R. J., Gremmen, B & Van Woerkum, C. M. J. (2012) Genomics, wat is dat? Gestuurde informatie verwerking door associaties. Conference Proceedings. *Etmaal van de Communicatiewetenschap 2012*. Leuven, Belgium.

Abstract

Public opinion is important for the success of a plant breeding practice. Currently, the relatively new practice of genomics-accelerated breeding is under development. From initial findings in research on consumer acceptance, it appears that people experience a strong link between genetic manipulation (GM) and genomics-accelerated breeding after hearing the name “genomics,” leading to an unfavourable evaluation of genomics-accelerated breeding. There are indications that when genomics is presented with the purpose of enhancing food production, the negative link with GM is perceived more readily than when it is presented for other purposes. In the current article, we study the transference of unfavourable attitudes from GM to genomics-accelerated breeding. We study, in the Netherlands and Ukraine, the role of the presented purpose in creating a perceived link between genomics-accelerated breeding and GM. In addition, we study the effect of the presented purpose on the attitudes towards both practices when the link is perceived. The results show that universally people use their attitudes towards GM to evaluate genomics. In a culture where GM is perceived as controversial (Ukraine), more favourable attitudes towards both practices can be created by presenting GM in relation to biofuel rather than to food.

Introduction

Public opinion is an important element in the success of a plant breeding practice. There is no better example than the failed introduction of genetic manipulation (GM), reflected in members of the public calling for prohibition of the technology and foods produced using it. Currently, genomics-accelerated breeding is being developed and applied to the production of new cultivars. Although research on the acceptance of genomics-accelerated breeding is still sparse, there are indications that it could be rejected by consumers, especially those who object to GM. Genomics-accelerated breeding is rejected because people link genomics to GM when they have to give meaning to the, for them, unfamiliar practice. Therefore, controversies relating to GM are threatening the development of genomics-accelerated breeding. In the current article, we show that there are indications that different elements in communications about the subject influence how people form unfavourable attitudes towards genomics-accelerated breeding by using their attitudes towards GM. The elements we investigate are the role of the *term* genomics, the presented *purpose* of the practice and the interaction with the extremity of attitudes towards GM. Using experiments, we test the influence of these elements on the emerging attitudes towards genomics-accelerated breeding. To test the interaction with the extremity of attitudes, the study is carried out in the Netherlands, where attitudes towards GM are moderated, and Ukraine, where GM is controversial.

Attitude formation and change

In the current study, we focus on the emergence of attitudes. Traditionally, research on the acceptance of plant breeding practices, especially GM, follows the presumptions of the literacy model (Scholderer & Frewer, 2003). The literacy model focuses on changing unfavourable attitudes into favourable evaluations. According to the model, people’s attitudes are related to the information they have about a technology, and providing information would change unfavourable attitudes to favourable ones (Ahteensuu, 2012). The model certainly appeals to common sense logic and is still adhered to by many technical experts (Ahteensuu, 2012). However, the relation between information and attitudes appears to be more complicated (Hansen, Holm, Frewer, Robinson, & Sandøe, 2003). In the field of GM acceptance, it has been found that people can have strong attitudes about the subject without having any knowledge (Frewer, Shepherd, & Sparks, 1994), and that providing information does not alter their convictions (Scholderer & Frewer, 2003). These findings undermine the presumed relationship between information and attitudes. Although an in-depth review of attitude formation is beyond the scope of this article, we give some attention to why information might not be important and create awareness about the way communication about genomics-accelerated breeding might influence attitudes to become unfavourable.

Attitudes are important because they guide our decision making (Albarracín, Johnson, Zanna, & Kumkale, 2005). People often need to make decisions, and therefore form attitudes, in situations where no technical details are available to them. For example, people might be confronted with genomics-accelerated breeding because they are interviewed about their opinions. In such situations, people will construct their attitudes by using any information they have available, including anything they link with the concept. Attitudes formed when required are called *constructed attitudes* (Fabrigar, MacDonald, & Wegener, 2005), and they might differ significantly depending on what information is available at the time either in the form of knowledge (Michaut, 2004) or present in the situation (Kahneman, 2003). These constructed attitudes can turn into *crystalized attitudes* (Fabrigar et-al, 2005) when people remember their evaluations. Importantly, people tend to remember their evaluations without remembering their basis (Kanouse, 1984). Therefore, attitudes formed from a vague notion or from concrete information can be equally influential on behaviour.

Because people remember their attitudes without being aware of what gave rise to them, it is important to understand the formation process, because attitudes are especially subject to influence during this formation. Technical details that experts want to use to influence attitudes often do not play an important role because people have to form their attitudes in situations where there are no details currently available. The question that remains is what, if anything, people use to shape their attitudes towards genomics-accelerated breeding.

Attitude formation towards plant breeding

From initial findings and experiences in the field of genomics-accelerated breeding, it appears that the name genomics is an important element in the attitude formation process. In a report on the public perception of genomics by van Dam and de Vriend (2002), the authors report that they suspect that people use their knowledge of GM to answer questions about genomics after hearing the name genomics. An explanation is that, when people hear the name genomics, they try to give meaning to the concept by using knowledge about genetic modification because it appears similar in name. The experiences of these authors are confirmed by experts working on genomics (Hall, 2010). They notice that people keep bringing up GM issues when debating genomics. In a study directly testing these experiences, we found that, when people are asked to respond to the name genomics (related to food), their evaluations of genomics are nearly identical to evaluations of genetic modification.

These patterns can be explained by categorization theory. According to that theory, familiar concepts are organized in people's minds in categories (Rosch, 1978; Loken, Barsalou, & Joiner, 2008). The categories are used to give meaning to an unfamiliar concept when one is encountered. Meaning is given to an unfamiliar concept by placing it in a category with familiar concepts. This is called categorization. After categorization, attitudes towards the familiar concepts can be extended to the new concept. When people try to give meaning to the genomics concept, they categorize the concept with GM and use attitudes towards GM to evaluate genomics, a process called *attitude extension* (Muthukrishnan & Weitz, 1991). The name genomics (in genomics-accelerated breeding or in other combinations) is acting as a conceptual label making people link genomics with GM. Therefore, the categorization of genomics with GM causes attitudes towards GM to be used to evaluate genomics.

Communication can play an important role in determining which category will be used depending on the name used in the communication (Herr, 1986; Higgins, 1989). When several categories potentially apply, a person evaluating an unfamiliar concept is more prone to use a category activated in his/her mind than an inactivated category (Ferguson & Bargh, 2004). The category used will lead to the evaluation of the new concept (Ferguson & Bargh, 2004). The idea of having competing categories is important in communicating about genomics. The technology shares features with both GM and traditional breeding (van den Heuvel, 2008) and both of these practices can be used to categorize and give meaning to genomics. However, the name genomics particularly stresses the technical commonalities with the controversial GM technology. The result is that the name steers people to form a link with GM exclusively because the name genomics activates the GM concept rather than the traditional breeding concept. Promoting a link with traditional breeding rather than GM would lead to more favourable attitudes. In earlier research, we found that, whereas the name genomics caused evaluations similar to those about GM, the fictitious name “natural crossing” caused evaluations similar to those about classical breeding (CB).

The role of food in attitude formation towards plant breeding

Food might be an important element in the categorization of genomics with GM. Van Dam and de Vriend (2002) note that they believe GM is especially used to evaluate genomics when the topic is about genomics for food. If they are correct, the spreading activation model offers an explanation (Collins & Loftus, 1975). According to that model, people form a link between concepts that are often experienced together. Moreover, concepts have a greater chance of springing to mind if they are partially activated when linked to a concept that becomes fully activated. Because the debate about GM is very often link to food, many people will form a link between them, and therefore there is a high chance of people thinking about food after hearing about GM. We believe that, when people talk about genomics, mentioning genomics partially activates the concept of GM, with the mentioning of food activating the concept of GM beyond the threshold, making it spring to mind. When GM is then used for the evaluation of genomics, mentioning food will have played an important role in the usage of the GM concept. In the case of genomics, both the name and the context of food used to communicate genomics are features promoting the categorization of genomics with GM, and to attitudes towards GM being used for evaluating genomics.

In the current article, we follow the most conventional definition provided by Eagly and Chaiken (1993, p. 1), which states that an “Attitude is a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour.” According to this definition, the initial evaluation of genomics is an (emerging) attitude. The observation that the evaluation of genomics might have been made on the basis of knowledge about GM that does not necessarily apply to genomics is irrelevant. The evaluation made by the evaluator is still linked to the genomics concept (or entity), determining the attitude towards genomics.

Food might influence attitudes in another way. There are indications that GM is especially controversial when presented with the purpose of food production (Frewer, Howard, Hedderley, & Shepherd, 1997; Marris, Wynne, Simmons, & Weldon, 2001; Pardo, Midden, & Miller, 2002, for similar effects of the purpose of food production on the acceptability of nanotechnology see Gupta, Fischer, & Frewer, 2012; Siegrist, Cousin, Kastenholz, & Wiek, 2007; Siegrist, Stampfli, Kastenholz, & Keller, 2008; Steenis & Fischer, 2016). That the majority of research on the acceptance of GM is in the domain of food production is such an indication. *Eurobarometer* provides more direct support, showing that GM for other purposes carries more approval (European Commission, 2010). Where the purpose of food production influences attitudes towards GM, there are indications that the technology used to produce a food simultaneously influences the perception of that food. People tend to appreciate food products less after receiving information that the product has been created using GM or genomics than after receiving information that it has been produced by more traditional means (van den Heuvel, Renes, Gremmen, van Woerkum, & van Trijp, 2008). A probable explanation is that people have an intimate relationship with their food (Rozin 1999) and therefore strive to cancel any uncertainty about any unexpected effects. In short, the combination of a new technology and food creates a less favourable evaluation of both. To summarize the influence of food, mentioning food possibly encourages not only categorization and attitude extension from GM, but also extension of a more unfavourable attitude.

Influence of presentation on attitude formation

The influence of the presentation of a context (the presented purpose) on attitudes towards a concept (genomics) shows that attitudes can be flexible. When communicating about GM in relation to food, a person might report a negative attitude towards GM because of fears. Yet, when this person is asked to report attitudes towards GM in the context of energy production (for example, enhancing biofuel production through GM), this same person might report favourable attitudes. The example shows that, by communicating different features tied to the concept, different reactions can be triggered. Because such reactions can develop into a more crystalized attitude when the evaluation is repeated, the way a concept is approached in communications about it can influence this attitude formation.

Attitudes are flexible because they are structures of different connected attitude features (Fabrigar et-al, 2005). Each of these features adds to the overall evaluation of a concept. In the GM case, uncertainty about the effects on food safety is one feature, and the ability to produce more biofuel is another. When an attitude is being retrieved or formed, the attitude will assimilate towards the evaluations of features emphasized by the context (Fabrigar et-al, 2005). When uncertainties are highlighted by mentioning food, the overall attitude towards GM becomes less favourable.

Proof that attitudes towards GM are susceptible to this mechanism is provided in a report on the relation between attitudes and biofuel production (Wegener & Kelly, 2008). The authors found that up to 71% of respondents thought it a good idea to use GM for biofuel production. Communicating genomics in relation to biofuel production might therefore lead to more favourable initial attitudes because people might not so readily link genomics and GM and, even if they do, attitudes towards GM will be more favourable.

To summarize, attitude formation can be influenced by the way communications make people think about related concepts. GM is evaluated less favourably than CB. Attitude extension to genomics from GM will therefore lead to less favourable attitudes than attitude extension from CB. Promoting the linking of genomics with CB rather than GM will lead to a more favourable initial attitude when attitude extension prevails. In addition, if genomics is linked to GM, more favourable initial attitudes can be created by communicating it in association with a purpose other than food production.

Differences in attitude extremity

There are large cultural differences in attitudes towards GM (European Commission, 2010). We expect these differences to result in different attitudes towards genomics after attitude extension. Moreover, such differences can have an impact on attempts to influence attitude extension. When attitude extension is being influenced by focusing on an attitude element, it is important that the element influences the overall attitude within the culture. For example, if within a culture there are no worries about food safety, changing the context of presentation to avoid food-related issues will not influence the overall attitude.

To study cultural differences, we carried out the same study in the Netherlands and in Ukraine to test the influence of food-related concerns. In previous research, we found that attitudes towards GM in the Netherlands were near neutral on average and without any extreme variations. This supports Gutteling’s (2002) finding that there is a variety of differing views on GM in the Netherlands, but they do not reach the point of controversy. In *Eurobarometer*, special interest is taken in attitudes relating to food. The results show that, in the Netherlands, 39% of respondents say that they do not have a problem with GM in food; this is the largest group within the EU (European Commission, 2010). We take these combined results as an indication that GM for food purposes is not controversial in the Netherlands. With food-related concerns not generally being important, alterations in the presented purpose of genomics might not cause large changes in attitudes towards it in the Netherlands.

In countries where worries about food safety are more salient, talking about biofuel instead of food might have a greater positive influence on emerging attitudes. To test the possible effects, we carried out our experiment in Ukraine in addition to the Netherlands. We selected Ukraine because it has a different culture than the Netherlands and there were indications that GM for food was a highly controversial topic there. At the time of data collection, the Ukrainian government was preparing strict food labelling laws. The laws required all food products to be labelled either "GM" or "GM free." Even food products with no connection to GM, for example salt, had to be labelled, and many food retailers told suppliers that they would not accept food without a "GM free" label (USDA Foreign Agricultural Service, 2010). Although some of these laws have been reversed, the developments, and especially food retailers' demand for GM-free-labelled food, show that GM for food was highly controversial at the time of our data collection. Therefore, attitudes resulting from attitude extension from GM to genomics might be influenced strongly by presenting genomics in the context of food rather than in the context of biofuel.

Current research

In the current research, we test the effects of presenting genomics in combination with different known technologies, GM and CB, and for different purposes, food or biofuel production. The aim is to study the attitudes caused by the name genomics alone. Therefore, no information about genomics is provided, and we test participants with little or no background knowledge of genomics.

We expect that mentioning food purposes will result in a more similar evaluation between genomics and GM, and in a less similar evaluation between genomics and CB. We expect that, when the presented purpose of the GM is biofuel production, the evaluation of GM will be more favourable and, therefore, the evaluation of genomics will be more favourable.

To test the influence of different evaluations linked to particular attitude elements, we run two separate experiments in the Netherlands and in Ukraine. We expect that mentioning biofuel rather than food will cause more favourable attitudes towards GM, and therefore towards genomics, in Ukraine especially. By comparing the results, we can determine the extent to which attitudes linked to food influence the overall emerging attitude.

Netherlands study

Method

Participants

A company was hired to recruit participants and to administer the study. The company used a database with volunteers who were invited to participate in the study by email. The emails were distributed so as to reach a representative stratification with respect to education and income of the adult population in the Netherlands. In the email, invitees were told that the aim of the study was to record their opinion about different agricultural techniques and that they had a chance of winning a hotel night in return for their participation. Further, the email presented a hyperlink leading to the experiment. By clicking on the link, the email receiver could join. The recruitment yielded 139 participants.

The experiment had a 2 (context: “genetic manipulation” versus “traditional breeding”) x 2 (purpose: “biofuel” versus “food”) design, and participants were randomly distributed.

Procedure

Introduction and manipulation

After clicking the hyperlink, the participants were redirected by computer to one of the conditions. First, the participants were asked to agree to a form of consent, explaining to them that the results would be processed anonymously and that they could stop at any time they wished. The experiment began by presenting a cover story explaining that aim of the research was to find out how people thought about different ways of making new cultivars for agricultural purposes. The cover story was followed by manipulation presenting two different purposes for agriculture: biofuel production and food production.

Participants in the biofuel group read:

"There is a limited supply of fossil fuels. Biofuels provide an alternative that can replace fossil fuels. Different agricultural techniques can help produce more biofuels. You are now going the read about one of these."

Participants in the food group read:

"We eat food every day. This food is produced by agriculture. Every day, people are trying to enhance the production of food using different agricultural techniques. You are now going to read about one of these techniques."

The application manipulation was followed by the context manipulation, which explained a way of making a new cultivar.

Participants in the traditional breeding for food context read:

"A way to develop a new variety is traditional breeding. When traditional breeding is applied, a plant's pollen is put on the flower of another plant. The new plant that results is a cross of the "parents" and will share characteristics with both of them. For example, a plant bearing many tomatoes and a plant bearing round tomatoes can be crossed to produce a plant bearing many round tomatoes."

For participants in the biofuel group, the last sentence read:

"For example, a sunflower that grows fast and a sunflower that produces a high amount of oil can be crossed to make a flower that produces a high amount of oil quickly after seeding."

Participants in the genetic manipulation context where presented the following text:

"A way to develop a new variety is genetic manipulation. When genetic manipulation is applied, a part of a plant's DNA is put in the DNA of another plant. From the new DNA, a plant will develop containing characteristics of both plants. For example, the DNA of a plant bearing many tomatoes can be combined with the DNA of a plant bearing round tomatoes to produce a plant bearing many round tomatoes."

For participants in the biofuel group, the last sentence read:

"For example, the DNA of a sunflower that grows fast can be combined with the DNA of a sunflower that produces a high amount of oil to make a flower that produces a lot of oil quickly after seeding."

After the participants pressed the continue button, an extra line appeared presenting the unfamiliar technology. For participants in the genomics context, the following text was added:

"There are more ways of developing new plant varieties. One of them is genomics."

Attitude measurements

After the manipulation, participants rated genomics on a selection of nine aspects on a 7-point scale taken from van den Heuvel, Renes, Van Trijp, Gemmen, & van Woerkum (2008). Examples of aspects are: the extent to which participants believed that genomics was useful (1 = not at all useful, 7 = very useful) and safe (1 = very dangerous, 7 = very safe). This scale was extended with two question about behaviour towards a product produced with the technology and inquired about the extent to which the participant was willing to eat food produced (use biofuel produced) with genomics (1 = absolutely not, 7 = no problem with it), resulting in a total of 10 questions ($\alpha = .94$). Participants were instructed to respond giving their first impression, and answer even if they did not know much about genomics. After genomics, the context technology was evaluated (genetic manipulation/traditional breeding) with the same questions ($\alpha = .96$).

Categorization measurements

Following these questions, the categorization measurement followed (see Figure 3.1). Participants were confronted with seven pictures. Each picture contained a line on which two circles where placed, and the distance between the circles ranged from full overlap at the middle of the line to the maximum possible distance apart on the line. In one circle, genomics was presented, in the other the name of the context technology. For example, participants in the GM group saw a picture of a circle with the name GM and a circle with the name genomics. Participants were asked to choose the picture that resembled most the way they felt the two technologies where related to each other (cf., Aron, Aron, & Smollan, 1992).

Control variable

The categorization measurements were followed by an open question, asking about the extent to which the participant was familiar with genomics (1 = unfamiliar, 2 = heard about genomics, 3 = very familiar). The answers to this question served as a manipulation check to determine whether or not people where familiar with genomics.

Results

Control variables

In the current study, we investigated the development of emerging attitudes towards genomics. To be able to do this, we needed participants who were generally unfamiliar with genomics. Eight participants who stated that they were very familiar with genomics were excluded. After removing the respondents, 131 participants remained.

Categorization and attitude extension

Using the graphical categorization question (Figure 3.1), we determined the extent to which participants perceived genomics to be similar to the familiar technology about which they read an explanation during the manipulation. A 2 (context) x 2 (purpose) ANOVA revealed only a significant main effect of context, $F(1, 127) = 4.86$, $p < .05$. Independent of the purpose presented in the context, genomics is seen as more closely related to GM, $M = 3.25$, $SD = 1.60$, than to $M = 3.90$, $SD = 1.61$.

With respect to attitude extension, the hypothesis was that people used their attitude towards the context technologies to form an initial attitude towards genomics. A scatter plot (Figure 4.1) revealed a clear relation between the attitudes towards genomics and GM for both purposes of GM. Within the GM for food group, linear regression revealed a significant correlation between the reported attitudes about genomics and GM, *B* = .52, 95% CI [.28, .77], $t(25) = 4.36$, $p < .001$, with the attitudes towards GM predicting a large portion of the variance of the reported attitudes about genomics, $R^2 = .43$, $F(1, 25) = 18.98$, $p < .001$. The result was similar for the GM for biofuel group, *B* = .71, 95% CI [.52, .90], $t(32) = 7.66$, $p < .001$, $R^2 = .65$, $F(1, 32) = 58.65$, $p < .001$. Following expectations, the results indicate that the attitude towards genomics is in line with the attitude towards GM. The results are similar for both presented purposes of GM. Therefore, it can be concluded that changing the purpose does not affect the attitude extension.

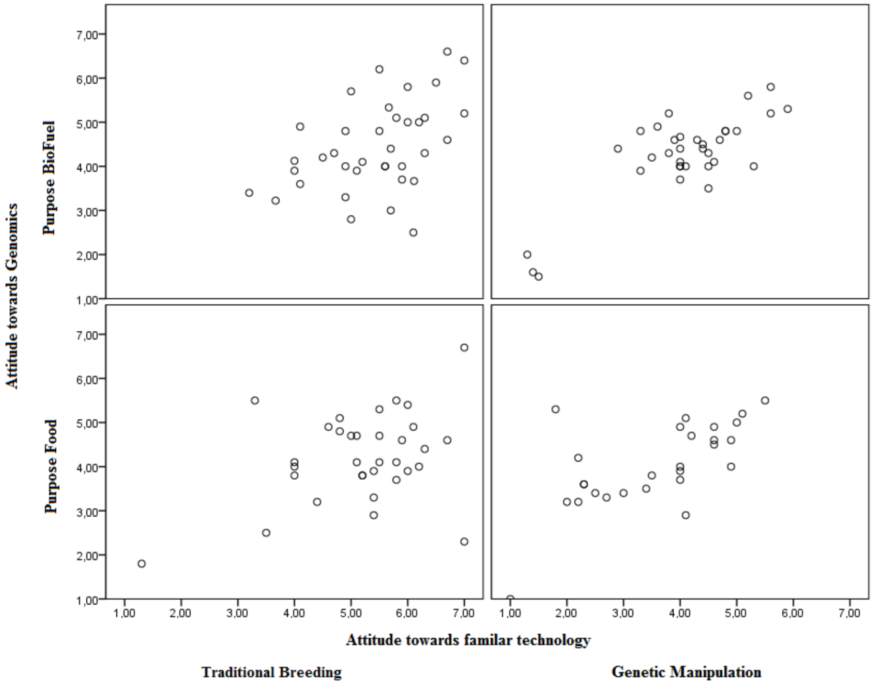

Figure 4.1 The relation between the attitudes towards, respectively, classical breeding or genetic manipulation and genomics for different purposes in the Netherlands

The scatter plot appears to show a weak correlation between the evaluations of genomics and CB for both purposes. Linear regression revealed a significant relation between the attitudes about genomics and CB for food purposes, *B* = .33, 95% CI [.03, .63], $t(31) = 2.27$, $p < .05$, $R^2 = .14$, $F(31) = 5.14$, $p < .05$ and the attitudes about genomics and CB for biofuel, *B* = .50, 95% CI [.17, .82], $t(35) = 3.12$, $p < .01$, $R^2 = .22$, $F(1, 35) = 9.75$, $p <$ 01. These results show that presentation does influence perception about genomics. However, the influences are rather weak.

Comparison effects

The results show that the attitudes towards CB can influence the emerging attitudes towards genomics to a small extent. The questions now are whether there is a difference between the attitudes towards GM and CB, because of both the nature of the technology and the purpose in the manipulation, and whether the difference is carried over to the emerging attitudes. A 2 (context) x 2 (name technology) ANOVA was used to see whether there was a difference between the context technologies. The ANOVA revealed only a significant main effect of context technology, $F(1, 127) = 60.33$, $p < .001$. GM was regarded less favourably, *M* = 3.85, *SD* = 1.16, than CB, *M* = 5.32, *SD* = 1.05.

A 2 (context) x 2 (purpose) ANOVA was carried out to see whether the difference in attitudes between CB and GM resulted in a difference in attitudes towards genomics. The analyses did not reveal any significant effects. It can therefore be concluded that the influence of the favourable attitudes towards CB did not influence the evaluation of genomics enough to create a difference in the emerging attitudes between the technologies. The average evaluation of genomics was near neutral, *M* = 4.26, *SD* = .98.

Discussion

We argued two possible ways in which the evaluation of genomics might be influenced through communication. The first way was the promotion of the link between genomics and either CB or GM. The second was to use the influence of the purpose of GM on the evaluation of GM when genomics was linked with GM. We begin by discussing the first way. We tried to promote the linking of genomics to

CB by not mentioning GM in the introduction, to prevent GM from springing to mind by avoiding the topic of food. Using a question that measured the perceived similarity between each presented technology to the respondent, we found that the people exposed to genomics and GM grouped the two technologies presented to them more closely together than the people exposed to genomics and CB. Not mentioning either GM or food did not result in respondents believing CB and genomics were equally close to each other compared to GM and genomics. In conclusion, the name genomics always leads to linking with GM and prevents linking with CB.

The results of the attitude extension test confirm the pattern. Attitudes towards genomics and GM correlated highly. The presence of CB in the manipulation had only little effect on the attitudes towards genomics, independent of the purpose. Due to the between-group design of the experiment, we were not able to directly test whether the respondents in the CB groups used their attitudes towards GM to evaluate genomics, which previous research found that people did. An indication that people use their attitudes nevertheless is provided by comparing the CB respondents' attitude scores towards genomics with the others' attitude scores towards GM. The score are very similar, indicating that all respondents used their attitudes towards GM to evaluate genomics.

The second way to possibly influence attitudes towards genomics (after attitude extension) was to change the evaluation of GM. By presenting GM in association with biofuel production, we expected more favourable attitudes towards GM compared to when it was presented for food production. However, the results show that the presented purpose did not change the evaluation of GM. Therefore, the subsequent attitude extension did not result in any differences in the evaluation of genomics.

The current results show that, among the respondents, the evaluation of GM in the Netherlands was neutral. This serves as an explanation as to why changing the purpose of GM from food to biofuel did not result in a significant difference in the evaluation of GM. We expect that, among cultures where GM is evaluated less favourably, changing the purpose might result in more favourable attitudes. In the

Netherlands study, we did not find any influence of the presentation context on attitudes towards genomics. A possible explanation might be the neutral evaluation of GM in the country. We test this hypothesis by repeating the study in a culture where GM is met with more resistance.

Ukrainian study

Method

For the Ukrainian study, a native research agency was hired. The research agency translated the questionnaires, and the translation was subsequently checked by a native Ukrainian speaker in the Netherlands. The agency recruited participants using its own database and was requested to create a representative sample with respect to education and income of the adult Ukrainian population. Participants were invited to join the study by email. The recruitment yielded 408 participants. The study was administrated using the internet. The procedure and questionnaires were identical to the first study, using the same attitude measurement for genomics (α = .91) and the context technology (α = .96), categorization measurement and manipulation check.

Results

Control variables

In total, four participants stated that they were very familiar with genomics. These participants were excluded from the analyses. After removing the participants, 404 participants remained.

Categorization and attitude extension

We used a 2 (context) x 2 (purpose) ANOVA to see whether the context and purpose had an effect on the strength of linking genomics with the context technology. The ANOVA revealed a main effect due to context, showing that genomics was seen to be more closely related to GM than to CB, $F(1, 400) = 50.62$, $p < .001$.

With respect to attitude extension, the hypothesis was that people use their attitude of the context technology to form an initial attitude towards genomics. A scatter plot (Figure 4.2) revealed a clear relation between participants' attitudes towards genomics and GM for both purposes of GM. Within the GM for food group, linear regression revealed a significant relation between the reported attitudes about genomics and GM, $B = .88$, 95% CI [.76, 1.01], $t(108) = 13.81$, $p < .001$, with the attitudes towards GM predicting a large proportion of the variance in the attitudes towards genomics, $R^2 = .64$, $F(108) = 190.58$, $p < .001$. The results were similar in the GM for biofuel group, $B = .77$, 95% [.66, .77], $t(92) = 13.96$, $p < .001$, $R^2 = .68$, $F(92) = 194.80$, $p < .001$.

The scatter plot revealed no clear linear pattern for either purpose for CB. Although linear regression revealed a significant correlation between participants' reported attitudes towards CB and genomics when CB was applied to biofuel, $B = .35$, 95% CI [.13, .57], $t(101) = 3.12$, $p < .01$, the correlation was weak, $R^2 = .09$, $F(101) = 9.72$, $p < .01$. When CB was presented as a means of food production, there was no correlation between the attitudes about CB and genomics, $B = .04$, 95% CI [-.18, .25], $t(95) = .34$, p = ns.

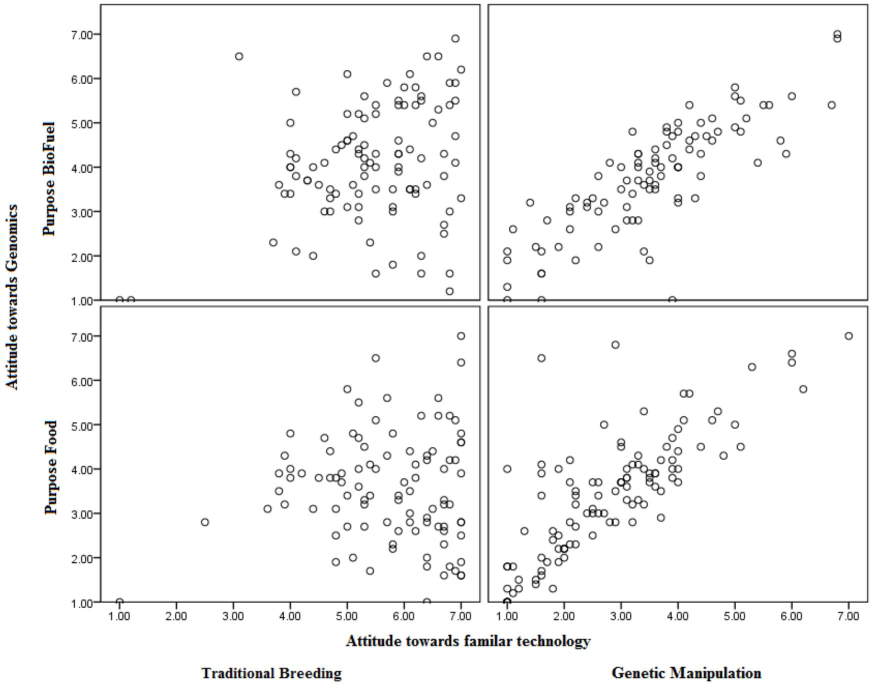

Figure 4.2 The relation between attitudes towards, respectively, classical breeding and genetic manipulation and genomics for different purposes in Ukraine

Comparison effects.

We expected that, when GM was considered controversial, changing the context from food to biofuel would lead to more favourable evaluations. A 2 (context) x 2 (purpose) ANOVA revealed an interaction effect, $F(1, 400) = 17.2$, $p < .001$. The interaction effect was caused by a difference in evaluation of GM caused by the purpose, $F(1, 400) = 17.9$, $p < .001$, with GM for biofuel being evaluated more favourably, $M = 3.52$, $SD = 1.34$, than GM for food, $M = 2.81$, $SD = 1.28$. CB was evaluated the same, independent of its purpose, $F(1,400) = 2.70$, p = ns. These results show that presenting GM as a means of biofuel production results in more favourable evaluations of GM compared to GM being presented as a means of food production. In addition, the 2 (context) x 2 (purpose) ANOVA revealed a main effect of context, $F(1, 400) = 391.6$, $p < .001$. CB was evaluated more favourably, $M = 5.57$, $SD = 1.13$, than GM, $M = 3.1$, $SD = 1.35$.

We used a 2 (context) x 2 (purpose) ANOVA to see whether the differences in evaluations of CB and GM resulted in different evaluations of genomics. The ANOVA revealed only a main effect for purpose, $F(1,400) = 11.1$, $p < .001$. Genomics for biofuel was perceived more favourably, $M = 3.94$, $SD = 1.29$, than genomics for food, $M = 3.48$, $SD = 1.33$, making the latter evaluation less favourable than that in the Netherlands ($M = 4.28$, $SD = 0.96$).

Discussion

In the Netherlands, it was found that people link genomics with GM, and that changing the purpose of GM from food to biofuel did not influence the perceived relation. In Ukraine, we observed the same result. Genomics is perceived to be closely related to GM, whereas people do not report a strong link between genomics and CB.

The attitude extension measurements show that attitudes towards genomics are mainly shaped by attitudes towards GM and weakly influenced by attitudes towards CB in the context of biofuels. When the presented purpose of the technologies was food, there was no longer a relationship between the attitudes towards CB and the attitudes towards genomics. The latter finding is in line with findings that more extreme unfavourable attitudes are more easily generalized (Shook, Fazio, & Eiser, 2007).

Although the attitudes towards genomics correlated highly with the attitudes towards GM, the attitudes towards genomics were less unfavourable than the attitudes towards GM. A possible explanation is that people feel reluctant to fully extend rejection towards an unfamiliar concept when they feel uncertain about being correct. Even so, the attitudes towards GM remained the primary predictor of the attitudes towards genomics.

The ANOVA testing the comparison effects shows that genomics is evaluated more favourably when it is presented in combination with biofuel than with food. There are two possible explanations. Because the attitudes towards genomics are always the result of the attitudes towards GM, the difference could be caused by the different evaluations of GM caused by the presented purpose. Another contributory influence could be that, when genomics is presented after biofuels, the attitudes towards CB have an effect on the attitudes towards genomics. The results from the ANOVA point to both explanations interacting. In the GM for biofuel group, attitudes towards genomics are slightly higher compared to the GM for food group. This can be attributed to the difference in evaluation of GM between purposes. The attitudes towards genomics in the CB for biofuel group were even higher, supporting the possible explanation of the influence of the favourable attitudes towards CB.

General discussion

In previous research, we confirmed the experience of other experts that, even though genomics shares elements with CB and GM, people universally use their attitudes towards GM to evaluate genomics. The use of the attitudes towards GM to respond to genomics is caused by the similarity in name. An important element in the study was that genomics was presented as a solution for creating new foods efficiently. The food purpose might be an important element in the process of activating knowledge and attitudes towards GM to judge genomics. In the current study, we studied the extent to which the presented purpose of genomics (food or biofuel production) contributed to the perceived link between genomics and a familiar technology (respectively, GM or CB) and the subsequent usage of knowledge and attitudes relating to the familiar technologies to evaluate genomics. To study the influence of differences in the intensity of the controversy about GM, the study was conducted in the Netherlands and Ukraine.

In both the Netherlands and Ukraine, reported attitudes towards genomics correlated highly with reported attitudes towards GM. We did not find an exception caused by either the familiar technology presented in combination or the presented purpose of the familiar technology. Using a picture with circles representing the technologies, we were able to more directly test the perceived link between the technologies. Although van Dam and de Vriend (2002) expressed the belief that people confused genomics with GM more often in a food context, the current results show that people link genomics with GM independent of the presented purpose. It does not appear that spreading activation made the concept of GM more accessible. We can therefor conclude that variations in the context do not influence the perceived link between genomics and GM. The effect of the perceived link between genomics and GM is shown in the evaluation of genomics, which is very similar to the GM evaluations of the majority of participants. Therefore, we can conclude that people universally believe genomics and GM to be very similar.

The relation between genomics and CB is more complicated. Neither in the Netherlands nor in Ukraine did we find people that paired genomics and CB. Nevertheless, attitudes did cause minor variations in the reported attitudes towards genomics. In the Netherlands, attitudes towards genomics were influenced by attitudes towards CB independent of the presented purpose. In Ukraine, the purpose did make a difference. Attitudes towards CB did influence attitudes towards genomics when the presented purpose was the production of biofuel. When CB was presented as useful for food production, the attitudes towards CB did not influence the attitudes towards genomics. A possible explanation is that the strong feelings towards GM when applied to food overrode the subtle influence of attitudes towards CB on the formation of attitudes towards genomics. Further research is necessary to draw conclusions on the role of extreme attitudes and context influences.

The weak influence of CB on attitudes appears to be at variance with Ferguson and Bargh's (2004) idea that, when more categories apply, the category that is used for categorization will be the source for evaluation. The results point to more categories influencing the emerging attitude. However, when the evaluation of CB did influence the evaluation of genomics, the effects were small. Although there was some influence, the influence did not lead to a significant difference in the evaluation of genomics. Therefore, the idea that a name can cause a particular attitude because people choose a certain category over another remains a useful way to approach categorization effects in practice.

In a recent study in the Netherlands, as already stated, we found that the average attitude towards GM is near neutral. The presented purpose of GM did not influence average attitudes, and we did not register a significant difference depending on whether the presented purpose was the production of biofuels or the production of food. In Ukraine, the overall attitudes towards GM were unfavourable. Here, the presented purpose did make an important difference, with GM for food being evaluated less favourably than GM for biofuel. The different attitudes are the result of the flexible nature of attitudes. In conclusion, when GM is controversial, changing the presented purpose from food to biofuel will result in more favourable attitudes. These more favourable attitudes towards GM will result in more favourable attitudes towards genomics.

Although there are differences between the Netherlands and Ukraine and the presented purpose, the dominant factor in attitude formation towards genomics was the link with GM. Any differences in the evaluation of genomics can be attributed to differences in the evaluation of GM.

Implications for communicating genomics-accelerated breeding

The results show the importance of the positioning of genomics-accelerated breeding. Because of the name genomics, people tend to use their attitudes towards GM to evaluate genomics-accelerated breeding. Because people tend to remember their evaluations and not the reason why they made them, attitudes can be very influential and harm the acceptance of products created with genomics-accelerated breeding and the development of the practice. The current findings show that, when the name genomics is used, institutions explaining genomics can, at least partially, prevent controversies by avoiding examples involving food. This, however, will often be very difficult to achieve.

The name genomics makes it very difficult to avoid attitudes towards GM being used to evaluate genomics. In previous research, we found that a name causing a link with CB caused more favourable evaluations. In the current experiments, we did not find any element that caused genomics to be regarded as close to CB. It is recommend that the name be changed before the technology reaches consumers. A new name could prevent controversies that arise due to beliefs founded on the idea that genomics means GM.

It is recommended that the selection of such a name should be carried out internationally. Although people universally link genomics with GM, there were differences between cultures on the effects of genomics. The differences were caused by different risk perceptions. Therefore, it is recommended to test the new name in different markets.

The elephant in the room: How a technology's name affects its interpretation

Based on: Boersma, R., Poortvliet, M.P., & Gremmen, B. (Under revision). *The elephant in the room: How a technology's name affects its interpretation*.

Abstract

In the current work, using experiments, we investigate the role of the name of a technology on the informed evaluation of that technology. We argue that a name can influence interpretations by activating cognitive structures. Using genomics accelerated breeding as a case, we show that the name "genomics" makes people evaluate related information as similar to genetic modification. Replacing the name "genomics" with "natural crossing" causes evaluations similar to those for traditional breeding. The results show that a name can have a strong influence on public attitudes, and we call for more consideration in choosing a name for a technology.

Introduction

In recent years, science communication has become an important part of the introduction of different applications of genomics in society (Bos, Koolstra & Willems, 2010; Pin & Gutteling, 2008; Mogendorff, et al., 2015). We have chosen genomics because public knowledge about this subject is still very limited (Sturgis, Brunton-Smith & Fife-Schaw, 2010). In addition, the name “genomics” influences people’s perception of the technology, according to reports of scientists communicating about it. According to these reports, people spontaneously believe that genomics is the same as genetic modification (GM) (Van Dam & De Vriend, 2002; Hall, 2010) and are hard to convince otherwise (Hall, 2010), even though the technology is in many ways similar to traditional breeding (Van der Heuvel, 2008).

Within science communication and related fields, there has been some attention focusing on what resources people might use when they lack appropriate or specific knowledge to evaluate a technology (Bucchi, 2008). Several alternatives have been proposed, including general scientific knowledge (Scheufele & Lewenstein, 2005), risk perception relating to other technologies (Bredahl, Grunert & Frewer, 1998), and existing attitudes (Grunert, Bredahl & Scholderer, 2003). Although these alternatives can substitute specific knowledge when a person is making an initial evaluation, something more is needed to explain how the evaluation is reached when the person does not have any specific knowledge about what he/she is evaluating. What remains unclear is what exactly will determine which particular knowledge, risks, or values are believed to be applicable and used in the evaluation. For example, will a person use attitudes towards biotechnology or towards asbestos to evaluate nanotechnology for food purposes?

An important feature of a technology is its name. Indeed, in several reports described below, indications can be found that for certain technologies the name of the technology plays an important role in its evaluation by the public. From these reports, a pattern emerges: to respond to an unfamiliar technology, people use a technology with which they are familiar and which appears related in name. This behaviour has been most notably observed in the fields of nanotechnology and genomics accelerated breeding, where researchers indicate that people confuse their technology with another, assumingly similar, technology because of the name, and that controversies are transferred even though they might not apply. With respect to nanotechnology, several authors have mentioned that people tend to link nanotechnology with asbestos, a dangerous nanoparticle, and subsequently reject nanotechnology in general (including safe variants) and related applications (Currall, et al., 2006; Macoubrie, 2008; Kampers, 2009). In the field of genomics, it has been reported that people believe that *gen*omics is equal to *gen*etic modification, which is regarded as controversial by many, making the evaluation of genomics unfavourable because of controversies that apply to GM (Van Dam & De Vriend, 2002; Hall, 2010). The reports point to people asking themselves “What is this technology?” and using the name to form an answer that is not necessarily right.

In the current paper, we test the influence of expectations caused by the name of a technology in interaction with information provided about the technology. More generally, we argue that a name can determine which cognitive structures present in a person’s mind will be used for evaluations. In addition, we assert that pre-existing cognitive structures serve as a basis for further interpretation and learning, and that this provides an explanation for the stability of existing attitudes when new information is presented. Using the relatively new practice of genomics accelerated breeding as a case, we study in an experimental setting the influence of the name of a technology, in combination with information provided about the technology, on the evaluation of the technology.

The case of genomics

As mentioned, experts report that people tend to believe that genomics equals GM (Van Dam & De Vriend, 2002; Hall, 2010) and use their evaluations of GM to evaluate genomics. The transfer of controversies from GM to genomics is particularly ironic, since genomics is often considered an uncontroversial and safe alternative to GM (Tester & Langridge, 2010). Genomics entails the studies of the function of the complete set of genes in a cell. When genomics is applied in plant breeding, traditional breeding is used to create new food products through natural sexual reproduction, whereas the use of GM in plant breeding involves the artificial recombination of genes. Compared with other methods, using traditional breeding to create new cultivars is far from controversial. The difference between genomics and traditional breeding lies in the fact that genomics is applied after reproduction to check whether particulate genes are present. From the perspective of reproduction and related risks, genomics is better understood when people apply their feelings and beliefs about traditional breeding rather than about GM. Because of the similarity of the name, people actually link genomics with GM when trying to give meaning to genomics. It is clear that, with all the controversies surrounding GM, the link between GM and genomics can potentially harm the development of genomics and the acceptance of any new genomics-assisted food products when they reach the consumer.

However, a name stressing the naturalness of the breeding practice might have the opposite effect. Research shows that natural (food) products are regarded as healthier, safer to consume and less risky for the environment to produce (Van Haperen, Gremmen & Jacobs, 2012; Rozin et al, 2004), which is the opposite of perceptions of GM (De Liver, Van der Pligt & Wigboldus 2005; Frewer, Howard & Shepherd, 1995; Wunderlich & Gatto, 2015). An important factor is the belief that 'tampering' by humans can introduce new risks and 'untampered' 'natural' contrast as being safe (see Rozin er al, 2004). Avoiding 'genetic tampering' and preventing (perceived) related risks is precisely one of the prominent reasons to apply Genomics.

Lay evaluations and knowledge development

For experts working on genomics, the rejection of genomics for reasons that apply to GM may appear surprising (Hall, 2010; see also Van Dam & De Vriend, 2002. However, it becomes understandable if account is taken both of the large number of technical innovations with which people are confronted and of the knowledge necessary to make evaluations using technical details. In an investigation on the public perception of genomics, respondents claimed that it took too much time to understand the complex material (Dijkstra & Gutteling, 2012). In such situations, people have to fall back on cognitive shortcuts to make decisions and evaluations (Scheufele & Lewenstein, 2005).

The combination of two important psychological mechanisms, *priming* and *categorization*, may provide such a shortcut. In the current article, we define priming as the activation of particular knowledge at the expense of alternative knowledge (Higgins, 1996). A name plays an important role in the activation of knowledge (Rosch, 1975). When experts communicate with one another using the name genomics, similar concepts are activated within their various minds. However, to activate that particular knowledge, the knowledge has to be present (Higgins, 1996). Although this might appear to go without saying, it is easily overlooked when experts create names that end up being used to communicate to the public, who do not have the knowledge to be activated. In such cases, the question is what will happen in the absence of the targeted knowledge structures.

A possible scenario is described in categorization theory, which describes a mechanism by which people give meaning to concepts with which they are unfamiliar. According to categorization theory, human knowledge is organized in categories of similar concepts (Rosch, 1978). New concepts with which people are unfamiliar can be interpreted by placing them in a category of familiar concepts that appear to be similar in some way to the unfamiliar concept (Loken, Barsalou & Joiner, 2008) – a process called categorization. Categories are depicted by a name, a *conceptual label* (Rosch, 1975; Rosch, et al., 1976). When people are confronted with an intangible concept of which only the name as a salient feature can be processed, a person can give meaning to that concept by searching for known (categories of) concepts that appear similar in name. As GM is generally familiar, the search for concepts that appear similar to genomics is prone to lead to thinking about GM, making the name genomics a prime for GM.

An important question that remains unanswered is whether people, when they have no information at all about what they are considering, will categorize it just on the basis of its name. Although from a rational perspective it might make sense to hold off making the initial categorization when there is no information or specific knowledge to justify a categorization, there are several indications that people might actually do the opposite. In situations where no information is available, people prefer a quick answer to the question of what a concept entails rather than an accurate answer (Kruglanski, Webster & Klem, 1993), especially in noisy daily-life situations where decisions are required (Kruglanski & Webster, 1996), such as while shopping for food in a supermarket.

In the literature, two possible explanations for this behaviour can be found. First, categorization can provide the basis for decision making through attitude extension (Muthukrishnan & Weitz, 1991). When attitude extension occurs, attitudes about the known concept are transferred to the new concept, whereby the attitudes towards the familiar concept can be used to make decisions about the unfamiliar concept. Second, when people know nothing to very little, categorization provides a frame of interpretation, whereby categorization can act as a first step in acquiring more information. In the words of Rosch (1975, p. 252), “to categorize a stimulus is to consider it.” Thus, categorization itself can be considered a form of understanding. To summarize, issues relating to a lack of knowledge can be solved by categorization, and a lack of knowledge can, therefore, enhance the need to categorize. In addition, the initial evaluation and the initial understanding are linked through the category used for categorization.

When categorization occurs, previously activated categories have a greater chance of being used than inactivated categories (Herr, 1986; Higgins, 1996; Sedikides & Skowronski, 1991). Therefore, if a category is primed by a name (such as GM by genomics), the primed category is prone to be used *rather* than appropriate alternatives. In addition, when information about a technology is provided, activated categories will influence the processing of information (Ferguson & Bargh, 2004). Someone processing information will stop using activated categories if they do not apply, but categories will continue to be used as long as they are deemed applicable (Ferguson & Bargh, 2004). It is difficult to see that a category does not apply when only little is information is known (or understood), making it improbable that people will search for an alternative one. In addition, expectations play an important role in what information is noticed, valued, and remembered (Herr, 1986; Higgins, 1996).

These mechanisms make it difficult for laypeople to realize when they are using concepts that are unsuitable to make an evaluation, especially when they are dealing with complex and ambiguous technologies. Therefore, the process of understanding a complex technology is not the result of learning the isolated facts; rather, it results from how the facts relate to present *and* activated knowledge, whereby a name can determine the eventual “shape” of understanding by activating present knowledge. When knowledge develops with new information, it will do so in terms of the initially activated cognitive structures and related attitudes; this explains why initial ideas and attitudes are very difficult to change.

Current research

In the current research, we experimentally test the influence of the name of a technology on the interpretation of information about that technology, using genomics as a case. We test the expectation that the name genomics will lead to biased processing of information, resulting in evaluations of the unfamiliar genomics shifting towards the evaluation of GM because of the name. In contrast, we expect a name that emphasizes the relation with traditional breeding to cause evaluations to shift towards evaluations of traditional breeding.

The main interest in the paper is the impact of the name on the informed evaluation of the technology. Therefore, we compare the evaluation of genomics, called either genomics or natural crossing, with evaluations of more familiar agricultural techniques: GM or traditional breeding. In addition, we aim at making the first experiment as little an intervention as possible. A challenge is that, when information is provided during an experiment, the research itself acts as an intervention. In many studies on perceptions about a technology, this is problematic since, after receiving information, the participants are no longer representative of the public, of whom the majority do not receive any information. Because we are interested in the reaction to information, this is not necessarily a problem. However, there are two possible pitfalls. The first is providing information that a person would normally not encounter. We aimed at approximating the information that can be easily found by non-experts and people without access to academic sources such as journals. Using easily accessible information is particularly important because research in the field of genomics has proved that people's motivation to search for information is minimal (Bos, Koolstra, & Willems, 2009). Surprisingly, we found that only very little publicly accessible information is available about genomics in general, or about genomics and plant breeding in particular. Representative of the lack of information is the website *everything about DNA* (www.allesoverdna.nl), created by the Netherlands Genomics Initiative (NGI). The website offers a dictionary of DNA-related terms, but, strikingly, there is no explanation included for the term genomics; neither is an explanation provided anywhere else, or on the websites of any of the still active genomics centres linked to the NGI. These findings, in combination with the finding that people search for only little information, show that experiment participants may be provided with too much information. However, we did find one website, www.plantgenomesecrets.org, to be a easily accessible source of information about genomics for agriculture. The information provided therein formed the basis of the information used in the experiment, both in context and amount.

The second pitfall is that, because of the artificial situation created, respondents might be able to pay attention to details that, due to distractions in everyday-life situations, would usually escape them. To prevent this from happening, distractions (cognitive load) can be introduced during experiments to approximate a more everyday-life situation.

Using experiments, we test the way the name genomics influences an informed evaluation. We do so by asking respondents to evaluate genomics after reading a short description of the technology. Using a between-respondents design, genomics is called either genomics or natural crossing. In addition, respondents are asked to read about and evaluate either GM or traditional breeding. By doing so, we can compare the evaluations of these with the evaluation of genomics, and see to what extent the evaluations are similar.

Study 1

Method

Participants and design

Participants were recruited and the study was administered by ThesisTools, a company specialized in web-based surveys. The company used a database with volunteers who were invited to participate in the study by email. The emails were distributed to reach a representative stratification with respect to the education, age, and sex of the adult population in the Netherlands. In the email, invitees were told that the aim of the study was to record their opinion about different agricultural techniques and that they had a chance of winning 25 euro for their participation. Further, the email presented a hyperlink leading to the experiment. By clicking on the link, the email recipient could join.

The experiment had a 2 (context: genetic manipulation or traditional breeding) x 2 (name technology: genomics or natural crossing) design, and participants were randomly distributed. In total, 218 (103 men) people participated. The average age was 50.8 years and all educational levels were represented. In attempt to create larger differences in evaluations, the more controversial sounding name “genetic manipulation” was used during the experiment rather than friendlier sounding “genetic modification”.

Procedure

Introduction and manipulation.

After clicking the hyperlink, the participant was randomly redirected to one of the conditions. First, the participant was asked to agree to a form of consent, which explained that the results would be processed anonymously and that he/she could stop at any moment he/she wished. To induce cognitive load, the participants were instructed to remember an eight digit number without taking any notes, which they had to reproduce after finishing the questionnaire. After the cognitive load was induced, a cover story explaining the aim of the research was presented. The story stated that the goal of the questionnaire was to study how people felt about different ways of making new cultivars for food purposes. The cover story was followed by a manipulation that presented a short explanation of either GM or traditional breeding.

Participants in the traditional breeding context condition read:

"In agriculture, new plant varieties are developed. A way to develop a new variety is traditional breeding. When traditional breeding is applied, pollen of one plant is put on the flower of another. The new plant that will result is a crossing of the 'parents' and will share characteristics with both of them. For example, a plant bearing many tomatoes and a plant bearing round tomatoes can be crossed to produce a plant bearing many round tomatoes."

Participants in the GM context condition where presented the following text:

"In agriculture, new plant varieties are developed. A way to develop a new variety is genetic manipulation. When genetic manipulation is applied, part of the DNA of one plant is put in the DNA of another. From the new DNA, a plant will develop containing characteristics of both plants. For example, the DNA of a plant bearing many tomatoes can be combined with the DNA of a plant bearing round tomatoes to produce a plant bearing many round tomatoes."

Then the name for the technology was manipulated. For participants in the genomics name condition, the explanation was followed by the text:

"There are more ways of developing new plant varieties. One of them is Genomics."

Participants in the natural crossing name condition read:

"There are more ways of developing new plant varieties. One of them is Natural Crossing."

After the participant pressed the continue button, a short explanation about genomics was presented, making it possible to compare the explanations. We tried to give a balanced explanation of genomics in terms of characteristics promoting the categorization with either GM or traditional breeding. For participants in the natural crossing condition, the name *genomics* was replaced with *natural crossing*. The remainder of the explanation was identical.

"When Genomics (Natural Crossing) is applied, knowledge about the genetic material of the plant is used. After two plants which both have their own favourable traits have been crossed, the DNA of the new plant is checked for the presence of the genes responsible for the traits. Afterwards, plants that are considered suitable can be used to further develop the new cultivar."

Attitude measurements.

After the manipulation, participants rated the unfamiliar context technology on fourteen aspects on a 7-point scale adopted from Van den Heuvel et al. (2008), which is a combination from several pre-existing scales that measure technology attitudes (Batra & Ahtola, 1991), product attitudes (Toncar & Munch, 2001) and consumer beliefs (Van den Heuvel, et al. 2007). Examples of aspects included the extent to which participants believed that the unfamiliar technology was useful (1 = very useless, 7 = very useful) and safe (1 = very dangerous, 7 = very safe). In order to test the effects on the acceptance of food produced with the technology, the scale was extended with three questions about participants' putative actions in relation to a product produced with the technology and about the extent to which each participant would be willing to buy, eat and serve food produced with the unfamiliar technology (1 = totally not, 7 = having no problem with), resulting in a total of 17 questions ($\alpha = .98$) (see Appendix for the entire scale). After the unfamiliar technology, the context technology was evaluated (GM/ traditional breeding) using the same questions ($\alpha = .99$).

A dilemma with the current research is that not necessarily all participants were unfamiliar with genomics. Previous research, however, showed that the wider public is still unfamiliar with genomics (Dijkstra & Gutteling, 2012; Sturgis, Brunton-Smith & Fife-Schaw, 2010). The familiarity measurement of Chapter 3, which was taken in a similar context as the current study, also showed a low familiarity on genomics. Measuring respondents' knowledge on forehand might give clues about genomics that would influence their first impressions, where post-measurement knowledge might be influenced by experiences obtained during the experiment. Therefore, the decision was made not to measure respondents' individual familiarity but approach the unfamiliarity at a group level, resulting in all responses being included even though it might attenuate the sensitivity.

Results

We investigated the relationship between attitudes towards a familiar technology (GM or traditional breeding) and attitudes towards genomics (called genomics or natural crossing) using two statistical procedures. First, we used an ANOVA to examine the effects of the name used to describe genomics in combination with the familiar technology on the average evaluation. The results show the extent to which average attitudes are influenced by the name in combination with the context. Second, we performed linear regression between the attitudes towards genomics and the attitudes towards the familiar technology. The results show the extent to which participants use their attitude towards the familiar technology to shape their attitude towards the presented unfamiliar technology directly.

Comparison effects.

Following categorization theory and the principle of using activated knowledge to understand new information, we expected attitudes towards genomics to be similar to attitudes towards GM, and attitudes towards natural crossing to be similar to attitudes towards traditional breeding. To determine the similarity, we first examined the observed attitudes towards GM and towards traditional breeding, respectively. Because respondents could compare genomics with the familiar technology, it is possible that the evaluation of, respectively, GM or traditional breeding were influenced by the name, genomics. To investigate this, we carried out a 2 (context) x 2 (name technology) ANOVA on the attitudes towards the familiar technology. The ANOVA revealed only a significant main effect of the evaluation of the context technology, $F(1, 214) = 96.05$, $p < .001$, indicating that the evaluation of the familiar technology was not influenced by the name used to describe genomics. GM was regarded more negatively, $M = 3.60$, $SD = 1.45$, than traditional breeding, $M = 5.29$, $SD = 1.04$. These average evaluations of the familiar technologies enable us to study the direction of the comparison effects (for an overview of all the averages and standard deviations see Table 5.1).

We expected attitudes towards genomics when called genomics to be similar to the attitudes towards GM, and attitudes towards genomics when called natural crossing to be similar to the attitudes towards traditional breeding. A 2 (context) x 2 (name technology) ANOVA revealed only a main effect due to the name, $F(1, 214) = 39.33$, $p < .001$. The name genomics caused a more negative attitude, $M = 4.04$, $SD = 1.42$, than the name natural crossing, $M = 5.21$, $SD = 1.23$ (for an overview of all the averages and standard deviations see Table 5.2).

The results show that changing the name used in the explanation of genomics has a significant impact on attitudes towards the technology. When we compare the attitudes towards genomics and the attitudes towards GM, we can see that they are very similar, and the same is true for the attitudes towards natural crossing and the attitudes towards traditional breeding. Thereby, the results point to attitudes towards genomics being dependent on the association created by the name of the technology. To test the pattern directly, we carried out a linear regression to see if attitude extension occurred.

Categorization and attitude extension.

With respect to attitude extension, the hypothesis was that the attitude towards a familiar technology would be used to form an initial attitude towards the unfamiliar technology. A scatter plot (Figure 5.1) shows a clear relation between the attitudes towards genomics and the attitudes towards GM.

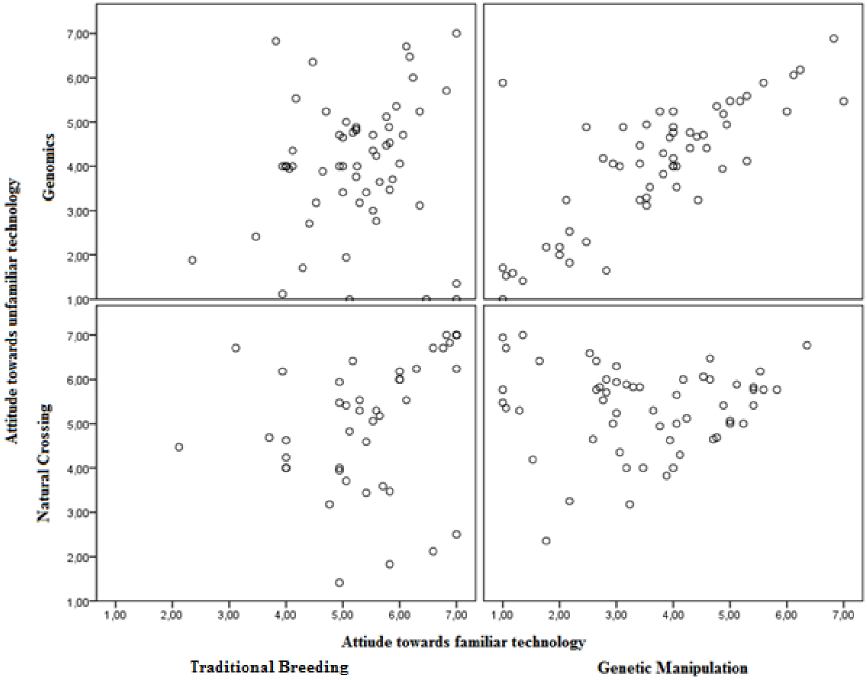

Figure 5.1: The relation between the evaluation of the familiar technology and the new technology under cognitive load (Study 1)

A less clear pattern appears between natural crossing and traditional breeding. Although there is a linear relation, the pattern displays more variance. Linear regression revealed a significant correlation between the reported attitudes towards genomics and towards GM, $B = .74$, 95% CI [.58, .90], $t(56) = 9.29$, $p < .001$, with the attitudes towards GM predicting a large portion of the variance in the reported attitudes towards genomics, $R^2 = .61$, $F(1, 56) = 86.24$, $p < .001$. When genomics is called genomics, there is a strong correlation between the attitudes towards genomics and the attitudes towards GM. No relation was found between the attitudes towards natural crossing and the attitudes towards traditional breeding, $B = .35$, 95% CI [-.05, .75], $t(41) = 1.76$, $p =$ ns.

The scatter plot does not show a relation between the evaluations of genomics and traditional breeding or of natural crossing and GM. Linear regression did not reveal a relation between the attitudes towards genomics and the attitudes towards traditional breeding either, *B* = .221, 95% CI [-.17, .62], *t*(58) = .1.13, *p* = ns, nor between the attitudes towards natural crossing and the attitudes towards GM, *B* = .014, 95% CI [-.17, .20], *t*(55) = .12, *p* = ns. These results confirm that the relation between the attitudes towards the unfamiliar technology and towards the context technology only exists for the combinations where the similarity in name creates the impression that the context is considered appropriate for categorization.

Discussion

In the introduction, we argued that a familiar plant breeding technology would be used to interpret and evaluate an unfamiliar technology if the name of the unfamiliar technology activated knowledge about a familiar technology. The results unambiguously show this to be true for genomics. The results show that the name genomics causes average attitudes towards genomics to be similar to attitudes towards GM, and linear regressions show a direct relation between the two.

The results also show that the average evaluation of natural crossing is similar to the average evaluation of traditional breeding. However, despite this and the scatterplot indicating a relation between the attitudes towards natural crossing and traditional breeding, linear regression failed to show a direct correlation between them. A possible explanation is that people generally have a favourable impression of traditional breeding and natural crossing, resulting in the majority of the scores to be located in a small part of the spectrum. This results in a ceiling effect, making regression analyses less sensitive, and, hence, the lack of a significant result may be caused by the distribution of the data (Cramer & Howitt, 2005, p.21). It is therefore difficult to determine whether or not a relation exists on the basis of the current results.

In addition to attitudes towards genomics and towards GM being very similar on average, the regression analyses show that the attitudes towards genomics are the direct result of the attitudes towards GM. When we compare the relationship between the attitudes towards genomics and GM and the attitudes towards genomics when called natural crossing and GM, we find that a change in the name completely undermines the perceived relationship. Even though all participants in the related experimental groups received the exact same description of both GM and genomics, a relation between the two was perceived only when genomics was called genomics. Using the name natural crossing instead of genomics caused the association between genomics and GM to disappear and resulted in more favourable evaluations.

Possibly the induced cognitive load had more impact than expected. It is possible that people were too busy remembering the numbers with which they were presented and therefore were unable to pay attention to important yet subtle details even less than could be expected in daily-life situations. To investigate the impact of the cognitive load, we administered a second study without a memory task was administered. The results show the extent to which the name influences an evaluation even when it is possible to pay attention without distractions.

Study 2

Method

Participants and design

For the second study, the same materials and sampling method were used. The procedure was modified by removing the cognitive load induction. The study was administered concurrently with the first, preventing participant to join both studies. The change resulted in the manipulation being presented immediately after participants gave their informed consent; this was followed by the measurement of attitudes towards the unfamiliar technology ($\alpha = .98$) and towards the familiar technology ($\alpha = .99$). With the cognitive load induction removed, participants were no longer required to reproduce a pre-given number at the end of the questionnaire.

In total, 228 (111 men) people participated. The average age was 54.2 years with a comparable distribution among educational levels as Study 1.

Results

Comparison effects.

Similar to the previous study, we first examined attitudes towards, respectively, GM and traditional breeding. In line with Study 1, a 2 (context) x 2 (name technology) ANOVA revealed only a main effect of the context technology, $F(1, 224) = 94.55$, $p < .001$, showing that the name of genomics did not have an effect on the evaluations of the familiar technology. Comparable to the first study, GM was evaluated less favourably, $M = 3.60$, $SD = 1.56$, than traditional breeding, $M = 5.26$, $SD = .97$ (for an overview see Table 5.1).

In line with the analytic procedure of Study 1, we carried out a 2 (context) x 2 (name technology) ANOVA to determine the influence of the name used in the explanation of genomics in combination with the context technology on the evaluation of genomics. The ANOVA yielded only a main effect of the name, $F(1, 224) = 39.33$, $p < .001$. When the name genomics was used, evaluation were less favourable, $M = 4.20$, $SD = 1.46$, than when natural crossing was used, $M = 5.00$, $SD = 1.33$ (for an overview see Table 5.2).

Categorization and attitude extension.

We expected the attitudes towards genomics to originate from the attitudes towards GM and the attitudes towards natural crossing to be guided by the attitudes towards traditional breeding. The scatter plot (Figure 5.2) shows a clear pattern between attitudes towards genomics and attitudes towards GM, and a less clear pattern between natural crossing and traditional breeding. Linear regression revealed a significant correlation between the attitudes towards genomics and the attitudes towards GM, $B = .65$, 95% CI [.46, .85], $t(53) = 6.75$, $p < .001$, with the attitudes towards GM predicting a large portion of the variance in the reported attitudes towards genomics, $R^2 = .46$, $F(1, 53) = 45.50$, $p < .001$. The results confirm that attitudes towards GM were used to evaluate genomics. Similar to Study 1, no significant relation was found between the attitudes towards natural crossing and the attitudes towards traditional breeding, *B* = .23, 95% CI [-.17, .63], *t*(62) = 1.16, *p* = ns.

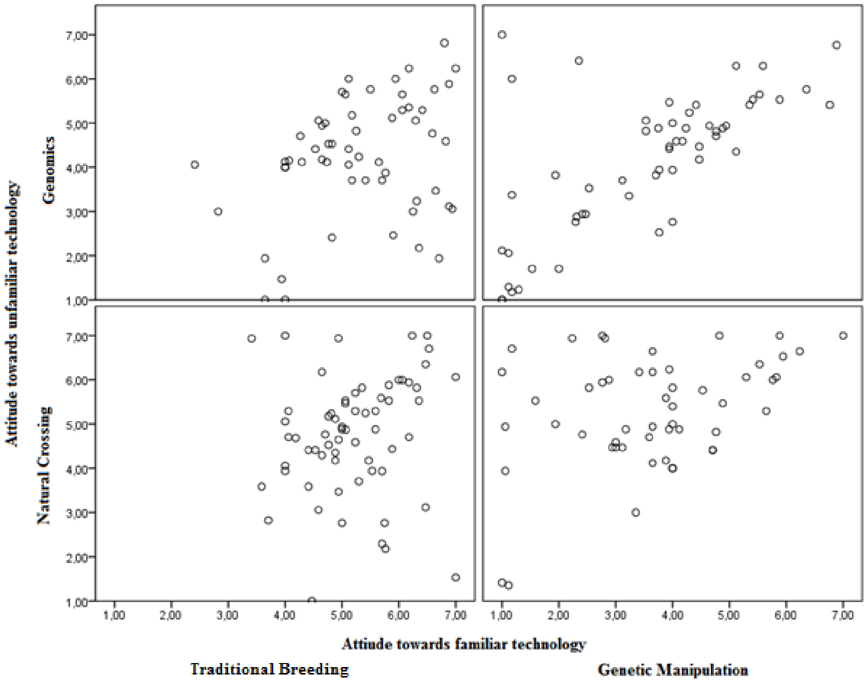

Figure 5.2: The relation between the evaluation of the familiar technology and the new technology without cognitive load (Study 2)

Different to Study 1, a significant relation was found between the attitudes towards genomics and the attitudes towards traditional breeding, *B* = .40, 95% CI [.08, .71], *t*(55) = 2.54, $p < .05$, with attitudes towards traditional breeding predicting a small portion of the variance in attitudes towards natural crossing, $R^2 = .11$, $F(1, 55) = 6.42$, $p < .05$. The relation between natural crossing and GM also proved significant, *B* = .33, 95% CI [.11, .55], *t*(50) = 2.94, $p < .01$, with the attitudes towards GM predicting a small portion of the variance in attitudes towards natural crossing, $R^2 = .15$, $F(1, 50) = 8.63$, $p < .01$. The results show that the attitudes towards the context technology influenced the evaluation of genomics even when the name did not encourage categorization.

Discussion

In Study 2, we removed the distraction procedure included in the first study to investigate its impact. The averages of evaluations of genomics (independent of the name used) approximate those of GM. Linear regression revealed a direct correlation between GM and genomics similar to Study 1, showing that the attitudes towards GM determine those to genomics also when people are able to pay more attention.

The observed pattern of evaluations of natural crossing is also similar to Study 1. The averages of natural crossing are closer to traditional breeding than GM. Yet, no direct correlation between natural crossing and traditional breeding is revealed by linear regression. The scatterplot indicates that the concentration of results might have caused a ceiling effect similar to Study 1.

Notably different to Study 1, linear regressions revealed positive correlations in both cases were the names were countervailing. To be precise, a more (un)favourable evaluation of the context results in a more (un)favourable evaluation of the technology. The ability of respondents to pay more attention to the descriptions of both the context and the new technology and to increasingly notice similarities can explain these findings.

To summarize, even in cases where people can pay attention and study the material presented, the bias remains. The name natural crossing causes more favourable evaluations than the name genomics. However, the ability to pay more attention does result in the information describing the context technology to influence evaluations in situations where a name does not encourage categorization.

In the current paper, we argue that the name of a technology activates cognitive structures used for both the interpretation and the evaluation of the information. In Studies 1 and 2, the name was presented before any explanation about the technology. A possible explanation for the findings is that the name steers people to pay selective attention to information that fits their expectations. Although the particular finding of selective attention can be considered important in itself, the mechanism we propose goes beyond causing selective attention while a person is exposed to the information and lasts during the processing of the information when a person is trying to understand the technology. Therefore, and even though we do not exclude selective attention being an element of the mechanism we propose, the effects should remain to a large extent even if a person is not influenced to pay selective attention to provided information. To be able to draw more robust conclusions, we repeated the study, but reversed the order of presentation of the name and the information. The aim is to investigate whether the influence does indeed persist without selective attention.

Study 3

Method

Participants and design

Study 3 followed the same procedure used in Study 2 with one modification: the manipulation was changed in such a way that the name genomics was presented after the explanation for genomics. To be exact, first the explanation of GM or TB was presented. The sentence introducing genomics, which followed the explanation, was replaced with:

"There is yet another method of developing new plant varieties."

In line with Studies 1 and 2, the text expanded with an explanation about genomics after the participant pressed the continue button. However, the name for the practice was avoided until the end of the information. The exact text presented was:

"When this method is applied, knowledge about the genetic material of the plant is used. After two plants that both have their own favourable traits have been crossed, the DNA of the new plant is checked for the presence of the genes responsible for the traits. Afterwards, plants that are considered suitable can be used to further develop the new cultivar.

This method is called Genomics (Natural Crossing)."

After the manipulation, participants were asked to evaluate the unfamiliar technology (α = .98) followed by the familiar technology (α = .99).

Study 3 was administered concurrently with the Study 1 and 2 to prevent duplicate respondents. In total, 226 (103 men) people participated. The average age was 52.0 years and the distribution among educational levels was comparable to Studies 1 and 2.

Results

Comparison effects.

Similar to Studies 1 and 2, we first examined the attitudes towards, respectively, GM and TB. A 2 (context) x 2 (name technology) ANOVA revealed a main effect of the context technology, $F(1, 222) = 94.21$, $p < .001$. Comparable to Study 1and 2, GM was evaluated less favourably, $M = 3.72$, $SD = 1.56$, than TB, $M = 5.44$, $SD = 1.09$. In addition, we found an interaction effect that bordered significance, $F(1, 222) = 3.86$, $p = .05$. The interaction effect was caused by a less favourable evaluation of GM when it was presented with natural crossing, $M = 3.40$, $SD = 1.56$, than when it was presented with genomics, $M = 4.06$, $SD = 1.52$. The results point to GM being compared to the context technology, meaning that participants did not finish their evaluation before reading about the unfamiliar technology. The evaluation of TB was not influenced by the name genomics (for an overview see Table 5.1).

We carried out a 2 (context) x 2 (name technology) ANOVA to determine the influence of the name used in the explanation for genomics in combination with the context technology on the evaluation of genomics. The ANOVA yielded a main effect of name, $F(1, 222) = 17.97$, $p < .001$. When genomics was called genomics, evaluations were less favourable, $M = 4.21$, $SD = 1.37$, than when the technology was called natural crossing, $M = 4.98$, $SD = 1.40$. Different to Studies 1 and 2, we additionally found a main effect of context, $F(1, 222) = 5.00$, $p < .05$, indicating that the average evaluation between genomics called genomics and genomics called natural crossing was more favourable when presented after the explanation of GM, *M* = 4.82, *SD* = 1.37, than when it was presented after TB, *M* = 4.41, *SD* = 1.47. The results show that, when the description of genomics is presented after the description of GM, genomics is evaluated more favourably (for an overview see Table 5.2). However, similar to Studies 1 and 2, genomics is evaluated less favourably than natural crossing.

Categorization and attitude extension.

We expected the attitudes towards genomics to be guided by the attitudes towards GM and the attitudes towards natural crossing to be guided by the attitudes towards TB. The scatter plot (Figure 5.3) shows a clear pattern between the attitudes towards genomics and the attitudes towards GM, and a less clear pattern between natural crossing and TB. Linear regression revealed a strongly significant correlation between the attitudes towards genomics and the attitudes towards GM, *B* = .79, 95% CI [.70, .89], $t(52) = 16.22$, $p < .001$, with the attitudes towards GM predicting a large portion of the variance in the reported attitudes towards genomics, $R^2 = .84$, $F(1, 52) = 263.23$, $p < .001$. The results confirm that the attitudes towards GM were used to evaluate genomics. Different to Study 1 and 2, a significant relation was found between the attitudes towards natural crossing and the attitudes towards TB, *B* = .49, 95% CI [.20, .79], $t(58) = 3.35$, $p < .01$, $R^2 = .16$, $F(1, 58) = 11.24$, $p < .01$.

The relation between natural crossing and GM proved significant, *B* = .22, 95% CI [.00, .45], $t(54) = 2.01$, $p < .05$, with the attitudes towards GM predicting a small portion of the variance in the reported attitudes towards natural crossing, $R^2 = .07$, $F(1, 54) = 4.03$, $p < .05$. The relation between the attitudes towards genomics and the attitudes towards TB did not reach significance, *B* = .27, 95% CI [-.10, .65], $t(54) = 1.46$, *p* = ns, with the attitudes towards TB not predicting any of the variance in the reported attitudes towards genomics.

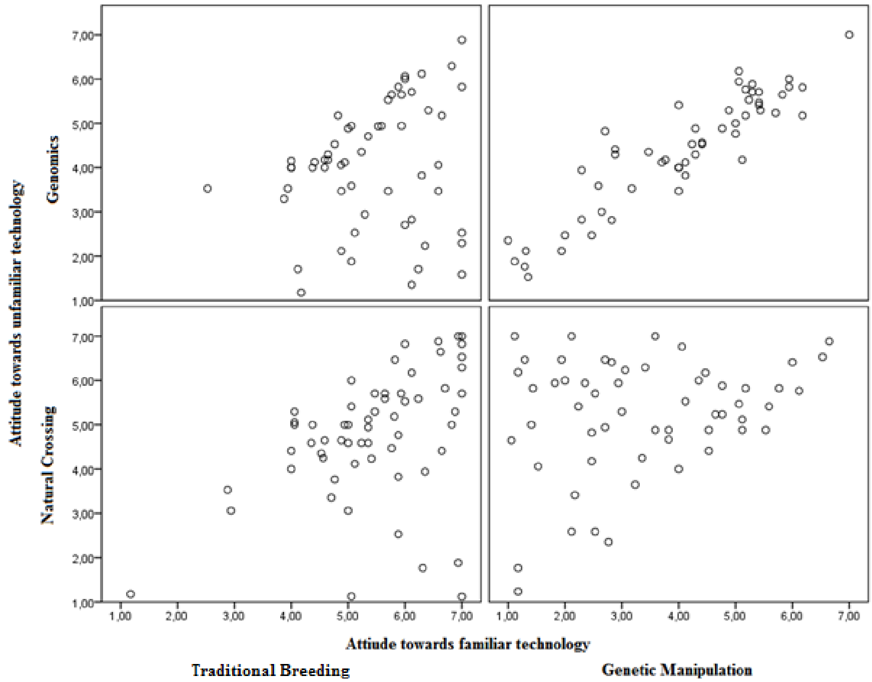

Figure 5.3: The relation between the evaluation of the familiar technology and the new technology after prolonged presentation of the name

Discussion

In Study 3, by presenting the name after the information, we aimed at investigating the effects of the name beyond causing selective attention during reading. We again found that the name genomics led to a less favourable evaluation than the name natural crossing. The evaluations of both genomics and natural crossing are very similar to those found in Studies 1 and 2. We can therefore argue that the results of Studies 1 and 2 cannot be fully ascribed to selective attention.

A limitation in the current design is that the name used for genomics was still presented in direct combination with the information. The possibility cannot be excluded that participants still read the name first. However, contrary to Study 1 and 2, we have found that the name used to describe genomics has an influence on the evaluation of GM and a main effect of context on the evaluation of genomics. We believe that the two findings are related and that the results follow a pattern that can be explained by the inclusion/exclusion model (Schwarz & Bless, 1992). According to the model, evaluations of different concepts presented successively can either influence each other or not, depending on whether a person has closed off the evaluation of the first concept before moving on to the next. In the previous procedures, a concrete, different plant breeding method was announced, whereas in the current procedure it was mentioned only that other plant breeding methods existed. In the current results, the influence of the name used for genomics on the evaluation of the context points to people finishing the evaluations of both the familiar and the unfamiliar technology simultaneously. The presence of this order effect, which we have not observed before, indicates that people did indeed judge the information in a different order than in Studies 1 and 2 because of the change in the time at which the name was presented.

Although there are some differences because of the order effect, the resulting evaluations of genomics and natural crossing are very similar to those found in Studies 1 and 2, confirming the importance of the name used to describe a technology once again, and this time beyond the stage of reading information and during processing of the information. Therefore, the results show that the perception of a technology can be influenced by the activation of related cognitive structures through a mere name.

General discussion

The results of the experiments provide strong evidence that the name that is given to a technology can determine the evaluation of that technology, even in the presence of information about the technology. The results show that, after people have formed an impression about what a technology entails because of its name, this impression colours the interpretation of information, rather than information influencing the impression. We therefore conclude that the name plays a key role in the technology evaluation process.

In the current paper, we used the relatively new technology genomics as a case and followed up on reports that people confused genomics with GM. We argued that people use knowledge relating to GM because the term genomics is meaningless to them. We hypothesized that people try to give meaning to the term meaningless term genomics by categorizing the concept and that, if they believe that they have found an appropriate familiar concept for categorization, they transfer their attitudes towards the familiar category to the new concept. Comparing the studies shows that people evaluate genomics by applying their attitudes towards GM after categorizing them together.

The current results are less clear about the relation between natural crossing and traditional breeding. The average evaluations resulting from the name natural crossing approximate those of traditional breeding and are also more favourable than those resulting from the name genomics. However, the results showed no direct relation between the evaluations of natural crossing and traditional breeding in Study 1 and 2, which was probably caused by a ceiling effect. Support for this notion is provided by the results of Study 3, in which a direct relation was revealed.

A notable difference to Study 1 is the presence of an influence of the information on the attitudes towards genomics in Study 2. As mentioned, the possibility to notice the commonalities between the descriptions of the context and genomics due to a lack of distraction can explain the presence of the influence. It is interesting to note, however, that the evaluations are still very close to those of the context technology; despite the observed influence of traditional breeding, the overall average attitude of genomics is closer to those of genetic modification. The same pattern can be observed in the case of natural crossing, which is evaluated similar to traditional breeding despite being influenced by the evaluations of GM. As such, it appears that both the initial categorization and the description of the context are influencing the evaluation at the same time, but in opposite direction. Both the average values of the evaluations and the amount of explained variance found using linear regressions indicate that the initial categorization sets a standard which is slightly influenced by noted commonalities. Study 3 showed that a name can also impact the evaluation of context technologies. The evaluation of genomics is, however, still primarily determined by the name used to describe the technology.

The results provide an answer to the question of what happens when people are confronted with a name that is meant to activate knowledge that is not present. Rather than passively doing nothing, or searching for the information, people try to give meaning to the concept by using knowledge that is already present. In other words, when a name targets non-existent structures, alternative structures become activated. Thanks to the alternative structures, the information provided can still be processed, but this can result in a different shape of understanding and attitudes than experts might have expected.

Conclusion

The results support the idea that people can form attitudes by using general scientific knowledge, risk perception, or existing attitudes. At the same time, they show that using these alternatives to detailed study can be not much more than a transfer of attitudes from known or familiar technologies to a new technology. The current chapter adds to previous findings that this process even occurs when information is provided that highlights unique features of this new technology. Although the transference of attitudes can be the result of a lack of cognitive effort, it is not necessarily the case. As mentioned in the introduction, the expectations and activated cognitive structures influence the processing of information, including what is noticed and remembered. Therefore, the process of copying can result from not being able to see the differences because of a lack of knowledge. By acknowledging the role of a name in interpreting new information, scientists can prevent people from drawing conclusions or forming attitudes that do not necessarily apply.

The current results show the necessity for experts to take into account the effects a name can have on the public. Because the public have a fundamentally different frame of reference than experts, a name can trigger unexpected reactions. We argue that science communication can benefit when experts develop their language not based on their own perspective, but on actively explored associations that people have, so that when the name goes public (for example when the technologies are introduced into society or consortia are being formed), names that create more appropriate associations can be used. If this approach is taken, people can get the right idea from their own frame of reference, without the need of extensive knowledge.

The effects of a name are not only overlooked by experts. Since the publication of the report *The public understanding of science* (Bodmer, 1985), there has been an ever-growing interest in scientific circles about the way people evaluate technologies (Gregory & Lock, 2008; Gupta, Fischer & Frewer, 2012). Unfortunately, in the field of science communication, there has also been hardly any direct attention has been paid to the role that a name can have. To the best of our knowledge, this is the first research to systematically investigate the influence of the name of a technology on the evaluation of information. Although the role of a name is sometimes mentioned as possibly having an influence, it is often merely a remark that the name caused some issues due to confusion or misunderstanding (for example, Ingold & Kurttila, 2000; Macoubrie, 2008). Moreover, many of the experiences about the public "not getting the name" are not even making it into the literature because studies are about the larger themes, such as the democratic position of the public in the development of new technologies.

An unrecognized problem is that a name is not just a source of misunderstanding; it is a conceptual label playing an important role in the shaping of evaluations and knowledge relating to the technology and the larger issues surrounding them. Naming is framing. Often, the name appears to be the elephant in the room. Understanding that the elephant is there can prevent many problems.

	Study 1[1]		Study 2[1]		Study 3[1,2]	
	Natural Crossing	Genomics	Natural Crossing	Genomics	Natural Crossing	Genomics
TB	5.43 (1.15)	5.18 (.96)	5.20 (.89)	5.32 (1.10)	5.45 (1.18)	5.43 (1.01)
GM	3.50 (1.42)	3.71 (1.48)	3.65 (1.49)	3.55 (1.64)	3.39 (1.56)	4.06 (1.51)

Table 5.1: Average evaluations of the context technology (resp. Traditional Breeding, TB, or Genetic Manipulation, GM) depending on the name used for genomics, standard deviation between parentheses; [1] main effect of technology, $p < .001$; [2] interaction effect, $p = .05$

	Study 1[1]		Study 2[1]		Study 3[1,2]	
	TB	GM	TB	GM	TB	GM
Natural Crossing	5.0 (1.50)	5.35 (.97)	4.76 (1.34)	5.31 (1.27)	4.76 (1.44)	5.23 (1.32)
Genomics	4.03 (1.45)	4.04 (1.39)	4.25 (1.35)	4.14 (1.58)	4.04 (1.41)	4.39 (1.31)

Table 5.2: Average evaluations of Genomics depending on the name and context technology used in explanation (resp. Traditional Breeding, TB, or Genetic Manipulation, GM), standard deviation between parentheses; [1] main effect of the name used for genomics, $p < .001$; [2] main effect of context, $p < .05$

General Discussion

Introduction

The aim of this dissertation was to investigate the influence of the name of a technology on perceptions and attitudes about it. The research was pursued from a cognitive psychological perspective; it was designed to ascertain what happens in people's minds when they lack the relevant theoretical knowledge to interpret a scientific concept by its name in a way deemed to be correct by experts who are using it. The influence of a name on the psychological process of making sense of a complex scientific construct was explored in a literature study and a series of experiments using genomics (in relation to plant breeding) as a case.

The series of studies was largely motivated by assertions from genomics experts that, in their view, people were not able to understand what genomics was (see for example Van Dam & De Vriend, 2002; Hall, 2010), even in direct conversations where experts were explaining the subject. It was reported that people started using aspects that apply exclusively to genetic modification (GM) to evaluate the unfamiliar genomics when confronted with its name, often leading to an unfavourable evaluation based on aspects that are actually unrelated to the technology. In addition, in discussions about genomics, people started to talk about GM instead. It was, therefore, postulated that, in the minds of the public, genomics was genetic manipulation. Abstract scientific names that cause confusion in communicating complex scientific concepts are not limited to genomics; similar confusions have been reported in relation to other technical and scientific names (see Chapter 1).

The way people replace genomics with GM illustrates how novel innovations can be at risk of being rejected by controversies that arise because people extrapolate from a familiar technology to the new one, even when the controversial aspects are not present in the novel innovation. It also shows the pivotal impact a name can have on the formation of (not necessarily correct) understandings and attitudes. A name can therefore be an important factor determining the degree of successful adoption of related innovations and policies through the understandings and attitudes that it shapes. Because of the omnipresence of names in communication, science communication can benefit significantly from understanding the influence of a name.

The goal of this dissertation was to address the gap in research on the role of a name in the formation of understanding of a novel technology. Particularly, the aim was to shed light on the public's formation of evaluations and understanding of scientific constructs that are difficult to comprehend. The approach is rooted in cognitive psychology, where especially categorization theory provides a promising approach to comprehend the formation of knowledge and understanding and, subsequently, evaluations. To investigate how people form an understanding of scientific constructs (genomics particularly) and how the understanding can be influenced by a name, a literature study and three interrelated empirical studies were carried out. The aim of the empirical studies was to systematically test the influence of factors claimed to be responsible for shaping understanding and attitudes in interaction with the name one step at the time. The results of these studies shed light on the role of the name in the evaluation and understanding of a technology by members of the public.

In this chapter, I first discuss the main findings of the studies. Then, I discuss the theoretical implications of the findings, followed by the practical implications.

Summary of the results

In Chapter 2, the aim of the literature study was to discover how initial understanding and attitudes are formed in a situation where a person does not have any knowledge about the topic at hand. In addition, we were interested in the role played by the name of a technology in this process. Central to the foundation of the public understanding of science approach in science communication is experts' assumption that unfavourable attitudes can be countered by providing knowledge, an assumption that remains popular today (Ahteensuu, 2012; Bauer, 2016). Educating the public, however, has proved ineffective in creating more favourable public attitudes (Bauer, Allum, & Miller, 2007). Another view that remains popular among experts is that people remain ignorant (or unknowledgeable) because they are too passive or too lazy to take an interest in science (Ahteensuu, 2012; Bucchi, 2008). However, with all the innovations in modern-day life, there is just too much to know in both quantity and complexity; the time necessary to investigate everything in a scientifically sound manner outweighs many times the time available (as postulated by Simon, 1979; for the effects of information being too much and too complicated in relation to public education on genomics see Dijkstra & Gutteling, 2012; Scheufele & Lewenstein, 2005). Therefore, in order to function in daily life, people are often forced to evaluate without knowledge or information being present. One efficient way to do so is by relying on categorization. By placing an unfamiliar concept in a category of familiar concepts, present knowledge about the familiar concepts can be used to evaluate the unfamiliar concept.

Categorization is also important in situations where information is provided, as it is an important part in learning. New information is interpreted by using present and activated knowledge structures. Therefore, when a name activates a category structure, the activated category structure can determine the shape of the understanding reached. This mechanism can lead to unexpected results when experts communicate with names that represent complex cognitive structures to laypersons, who use elementary models for understanding. Experts' and laypeople's cognitive structures are incompatible in the sense that laypeople's basic structures do not facilitate the comprehension of messages from experts who are using an extended network of categories, because laypeople are forced to use single examples and isolated categories to interpret complex information.

In Chapter 3, the aim was to investigate the effects of the name of a technology on uninformed evaluations and decisions. The proposed categorization mechanisms were systematically tested in an experiment using genomics as a case. The results showed that participants used categorization to reach evaluations and that the name of the technology was used as the basis for the categorization. In addition, the results showed that the unfamiliar concepts were evaluated by applying the pre-existing attitudes linked to the category used for categorization in a sort of copy-and-paste fashion. The result showed that genomics was evaluated similarly to

GM, whereas a fictional breeding method called *natural crossing* was evaluated similarly to traditional breeding.

An additional aim was to investigate the extent to which personal differences might lead to people quickly reaching decisions and evaluations based on categorization. According to theory on the need for closure, the need for closure is a personal trait; some people experience a stable high need for closure and want to draw conclusions quickly, whereas others experience an avoidance of closure and postpone their evaluation until they have the opportunity to study matters further so as to prevent inappropriate conclusions. The results showed, however, that, against expectations, attitudes towards the unfamiliar concepts were nearly identical to the attitudes towards the associated familiar concept uniformly and independent of a personal need for closure. According to the literature, people who would normally avoid closure draw quick conclusions nonetheless when their preference for more information cannot be satisfied due to a (situational) lack of it (Kruglanski, Webster, & Klem, 1993). With respondents showing different preferences in collecting information before making a decision, the results provide proof that people can turn to category-related attitudes when they are forced to evaluate without information even when they prefer to reach informed evaluations.

In Chapter 4, the aim was to examine the influence of risk perception relating to food on evaluation and categorization. Previous research indicates that GM is perceived as risky and unfavourable, especially when applied to food. The results showed that, in a culture where GM was perceived as controversial, changing the purpose from food to biofuel resulted in more favourable evaluations of GM, which, in turn, resulted in more favourable evaluations of genomics. However, the effect was absent in the Netherlands, where the average evaluation of GM is neither favourable nor unfavourable, and therefore less controversial. Another effect of perceived risk found in the literature is that risk leads to more perceived similarity. Yet, the results do not indicate a stronger categorization by people with higher risk perceptions. The explanation can be found in the fact that the correlation between the attitudes was very high in the first place. The finding fits the idea that the categorization is realized using the name alone, rather than specific technical details (which had to be present in the mind of the evaluator) that become more important under threat.

In Chapter 5, the purpose was to investigate the influence of activated knowledge on the evaluation of provided information. From the finding in Chapter 2 that categorization provides the basis of learning, it was assumed that, through categorization, the name can have an important impact on learning by determining what information is being noticed, and how it is interpreted and evaluated. The results showed that, when information about genomics was provided, the name used for the technology was still the primary predictor of the evaluations; the presented information did not influence the results to a practical, meaningful extent. Therefore, the results show that the information provided is interpreted using already present knowledge, rather than altering the knowledge and that, therefore, a name can have a long-lasting impact even when learning can potentially take place.

The results of the different chapters are combined and represented in Figure 6.1.

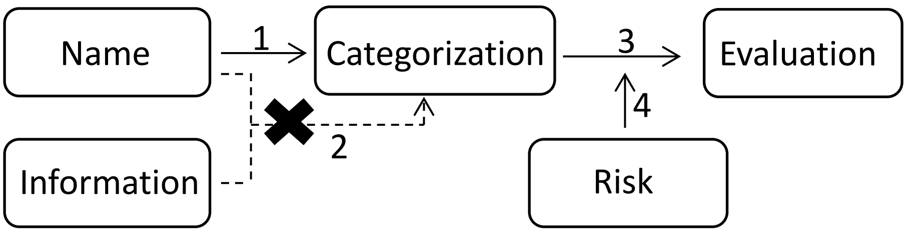

Figure 6.1 Schema of the research, which is interpreted as follows. (1) The name of a technology determines its initial categorization (Chapter 3). (2) Contrary to popular belief among experts, understanding is not based on technical information (Chapter 5). Rather, categorization and information interact the other way around: categorization of the concept provides a frame of interpretation for the information provided (Chapters 2 and 5). (3) Evaluation is reached by attitude extension (Chapters 3, 4, and 5). (4) Attitudes, however, are malleable and depend on risk perceptions about the purpose of the technology rather than the technology itself (Chapter 4).

Theoretical implications

The central topic of the current dissertation is how laypeople are influenced by the name of a scientific concept that they are trying to understand and evaluate. Therefore, the primary theoretical implications relate to the role played by a name in science communication. The research shows that the name of an unfamiliar innovation can activate present cognitive structures. These structures provide a frame of reference for reaching evaluations and interpreting information. This framing effect is discussed first. It is easy to state that acting on a name without any further information is irrational. However, Simon's (1955, 1979) theory of bounded rationality provides an alternative view: the strategy of acting on a name can be considered a rational strategy when other sources of information are absent or too complex. In such situations, the name acts as a heuristic. This view is discussed second. Theoretical implications in relation to other fields of research that contributed most predominantly to this dissertation – consumer behaviour and social prejudice – are discussed last.

Evaluations: Naming is framing

The results of this dissertation show that the name of a technology can determine evaluations of the technology to a large extent. To our knowledge, the results provide the first empirical evidence that the name of a technology can play an important role in the formation of understandings and attitudes towards that technology. In addition, the current research is to our knowledge the first to attempt to establish a working theory on how the name influences these understanding and attitudes. To date, the attention paid to a name was mostly limited to showing that the name caused misunderstanding or was a more philosophical retrospective reflection on the contribution that a name might have made to the formation of public attitudes. An example of the latter is the elaboration on the name genetic engineering, which came under suspicion of adding to the controversy (see for example Hansen, 2010). This research adds to these reflections in that it provides proof that certain names can trigger an evaluation process. Moreover, the findings also show that a name can trigger an almost universal strategy of reaching a conclusion; almost all participants tried to form a sort of understanding about genomics by categorizing it with GM. Although the process will not always be the same as in the case of genomics, the results do show that a name can be tested to see whether there are any patterns that can potentially cause issues in misguided evaluations or confusion.

The current results fit previous findings that people with low expertise do not base evaluations on technical knowledge but use alternatives instead. In the case of genomics, laypeople have stated that there is just too much to know and that it would take too much time and effort to reach the required level of knowledge (Dijkstra & Gutteling, 2012; see also Bos, Koolstra, & Willems, 2009). According to Scheufele and Lewenstein, (2005), an alternative to using directly related knowledge is to use, among other things, knowledge and risks related to other technologies. In addition, Van Giesen and colleagues argue that people can search for aspects pointing to familiar concepts, so-called reference points, to use related cognitions to evaluate an unfamiliar technology (Van Giesen, Fischer, Van Dijk, & Van Trijp, 2015; Van Giesen, Fischer, & Van Trijp, 2016). The current work contributes to these findings in two ways. First, it shows how the process of using other technologies can take shape; existing attitudes shift from a familiar technology to the new unfamiliar one when people can categorize the latter with the first. Second, the findings show that a name can act as a strong reference point and can play a crucial role in determining which more familiar technologies will be used for categorization.

The categorization not only determines initial cognitions and evaluations, but also impacts the subsequent development of cognitions. The results in Chapter 5 show that the name had more impact on the following evaluations than the technical description provided. Genomics can be regarded as a form of breeding in between a traditional method and GM (Van den Heuvel, Renes, Gremmen, Van Woerkum, & Van Trijp, 2008, see also Chapter 1). A technical description of genomics therefore contains elements of both, and, through priming, a name can determine the elements noticed. This finding illustrates that the way knowledge develops can be determined by the name used to describe a scientific concept and also which fact people will remember and possibly use in voicing their opinion.

A number of authors show that people can evaluate a technology on ethical rather than technical grounds (Sparks, Shepherd, & Frewer, 1994; Frewer & Shepherd, 1995; Frewer, Howard, & Shepherd, 1997; Cook, Pieri, & Robbins, 2004). The current findings show, however, that these more ethical concerns can be related to other technologies rather than to the technology at hand. Thus, the results demonstrate that guessing about what a technology is can be combined with elaborate thinking (see also Chen, Duckworth, & Chaiken, 1999). This can result in a well elaborated and articulate evaluation on ethical grounds after finding an answer (not necessarily correct) to the question: What is this technology? In these cases, the evaluations can be unrelated to the central topic and actually be related to other topics.

An answer to the question of what a technology entails, *any* answer, can help people move on to thinking or making decisions without elaborate research. This process shows similarities with heuristic decision making in Simon's (1955, 1979) theory of bounded rationality, a view that is now explored in more detail.

The name as a heuristic

The results show that people solve their lack of information about genomics by categorizing it with GM when they have to make decisions. From this perspective, it can be argued that the name of the technology is used as a heuristic to make decisions and reach evaluations. This research is inspired, as already stated, by experts' observation that people confuse genomics with GM. The term confusion has an unfavourable connotation when used by experts, and acting on it borders on irrationality. Confusion at the very least appears to triggers the deficit type of thinking that education should be used to correct people suffering from it. The perspective of a name as a heuristic, however, provides a focus on people's intent when names are used to give meaning and on their rationale for doing so. To elaborate, it is necessary to further explore the nature of heuristics.

Nowadays, the term heuristic has become somewhat of a container concept that is often used when people are affected by cues when making decisions (Shah & Oppenheimer, 2008).[9] The view that a name acts as a heuristic is most appropriate if heuristics is approached in the same way as Simon does, who introduced the term in research on human judgement and decision making. Until then, it was argued that a judgement was rational only when all related information was used, or at least a voluminous amount (Simon, 1955), and carefully deliberated; judgments reached by other means were irrational. Simon argued that, in everyday-life situations, people are often unable to collect and process all the information because they are bounded

[9] The use of the term heuristic has evolved strongly since its introduction into human decision making. Simon marks the beginning of heuristics use in human decision making, after it had begun to play a role in mathematics and artificial intelligence. As stated, Simon (1979) argued that heuristics is used to limit information search and is part of rational yet efficient decision making. Simon (1979) defined irrational decision making as based on affect or emotion. Since its introduction by Simon, heuristics theory has been further developed by others. Notable subsequent research on heuristics includes Kahneman and Tversky's work (see Kahneman, 2011, for an overview of their work) and dual process theories of persuasion, such as the Elaboration Likelihood Model (ELM) and the Heuristic-Systematic Model (HSM). However, such research often takes a fundamentally different approach to heuristics (Albar & Jetter, 2009; Gigerenzer & Gaissmaier, 2011). In Kahneman and Tversky's work, heuristics can be defined best as limits in human information processing rather than limiting information search and often focuses on errors in judgement (Gigerenzer & Brighton, 2009). They illustrate heuristics often by presenting *all* relevant information in their experiments; the extensiveness of information search is not the issue. For example, they show how people do not apply probabilities presented to them when making judgements (Tversky & Kahneman, 1982) and act differently when possible consequences are framed as loss versus gain (Khaneman & Tversky, 1979; Tversky & Kahneman, 1992). In this approach, visual illusions caused by drawings (which contain all information about the drawing itself) are heuristics also (Kahneman, 2011, p. 100). Dual process theories (Chaiken & Trope, 1999) stipulate that people can process presented information in two different ways, either consciously thinking about a message or processing it with less cognitive attention, relying on cues and heuristics instead. Feelings and emotions play an important role in heuristic processing (Petty & Cacioppo, 1986). See also affect heuristics for a mixture of heuristics and affect (Slovic, Finucane, Peters, & MacGregor, 2007). Although Simon distances heuristics from emotions (see Simon, 1997, p. 319), they are closely related in other approaches. The focus of the current research is the more cognitive process of sense making and making decisions without extensive information. Consequently, and to avoid confusion about the current nature of heuristics, Simon's approach to heuristics is followed.

by, among other things, time constraints (Simon, 1979). The consequence of this, however, is not that people are irrational. Instead, humans are considered to have a rationality that is bounded (Simon, 1990). To cope with our inability to collect and process all (theoretically available) information, we use heuristics: effective decision rules using a subset of related information to arrive at a satisfactory conclusion.[10] So, within a Simonian approach, heuristics are tools to be rational (even though we fail to meet the impossible standard of traditional rationality) (see Simon, 1990).

The present research shows that people reached judgments about genomics by categorizing it with GM. Thus, the categorization process is used as a heuristic to reach an evaluation. This also means that the process is rational in nature according to the bounded rationality perspective. However, evaluating a completely unfamiliar concept (through categorization) raises the question of whether the qualification of the process as rational can still be maintained. There are two ways of approaching such a question. First, it can be argued that, in such cases, judgements are the result of a *very* bounded rationality. With the theory of bounded rationality not describing any particular requirements on the concept of heuristics, the answer would therefore simply be yes. Another perspective, which possibly offers more potential for bridging the gap between the public and experts, argues that people employing such a strategy are trying to achieve a rational judgement in a situation where there is no information other than the name. People are therefore not so much rational in the sense of reaching a certain standard of correct beliefs but rather in their intent and behaviour (see also Simon, 1955, 1956).

Approaching the name as a heuristic and therefore a rational strategy can help prevent viewing the public as lazy. It also creates the opportunity to look at how the results of using heuristics can result in more appropriate judgements and beliefs by providing alternative input; in this case the name. Thus, treating the name as a possible heuristic fortifies the idea that understandings can benefit from a

[10] In Simon's approach, people limit their information search until a satisfactory decision can be made. In a related view, this is presented in the cognitive miser model, in which it is assumed that people will only spend the minimal amount of effort required to reach an evaluation (Fiske & Taylor, 1991; see also Orbell & Dawes, 1991; applied to science communication, Scheufele & Lewenstein, 2005)

different name, while stressing the rationality of using the name to reach evaluations.

Potential advances in science communication from other fields

The process of categorization is an important aspect of reaching evaluative decisions and of the name acting as a heuristic. The effect of categorization on perceptions is also an important theme in other disciplines; and categorization is an important theme in both marketing and consumer behaviour and research on social prejudice. Paying more attention to findings in these disciplines can help to further enhance understandings of public perceptions about technologies of important interest to science communication. I now discuss the contribution that these fields can make to science communication in more detail, and, when applicable, the contribution of the current research in return to marketing and consumer behaviour and categorization theory.

In an important way, marketing and consumer behaviour research may be considered an antonym to public understanding with respect to understanding. The public understanding of science approach, as a subtheme of science communication, has developed from the perspective that the public's ignorance is blocking support (including consumption) for science and technologies (see Bodmer, 1985). To counter the lack of support, public understanding should be enhanced to correct unfavourable evaluations. In marketing and consumer behaviour, the aim is to enhance public understanding to improve marketing activity (for example, Wright, 2006, p. 49, argues that "detailed information and a deep understanding of the needs and wants of the customer … coupled with the ability to offer correct benefits, is the basis for consumer satisfaction"). From this perspective, it can be argued that the public understanding of science approach tries to correct ignorance to enhance consumption or other forms of support, whereas the marketing and consumer behaviour approach tries to enhance consumption by understanding the customer including his/her ignorance.

The deficit model finds it roots in the hypothesis by experts that there is an important relationship between knowledge and evaluations, sometimes called the *rationalist approach* (Bauer, 2009; Wynne, 1993). In the rationalist approach, rational attitudes are based on scientific facts and information (Bauer, 2009). Therefore, the rationalist approach leads to certain blind spots in research. Factors shaping perceptions and behaviours that are deemed irrational are ignored, such as perceptions derived from a name. However, in marketing and consumer behaviour, naming is an important topic. In marketing, it is recognized that a name can play an important role in the meaning given to a product and the attitude formation towards the product by transference of attitudes from a category to which the product belongs (see for example Broniarczyk & Alba, 1994, Loken, Barsalou, & Joiner, 2008; Rangaswamy, Burke, & Oliva, 1993).

The results of the current research show that insights from marketing and consumer behaviour in relation to categorization and attitude formation can also be relevant for attitude formation relating to topics pursued in science communication. Therefore, a deeper interest on the part of science communication in marketing and consumer behaviour research could augment the insights into public understanding and attitude formation, especially in areas where rationality (in its traditional view and related to being educated and collecting all the facts) does not play a role in understanding and evaluations.

This research adds to marketing and consumer behaviour in showing that the use of categories in forming an understanding and evaluation also applies to intangible concepts. In marketing and consumer behaviour, the effects of categorization are related to either physical objects (for example, how is a new type of product, such as a rapid electric bike, categorized, as a fast bike or a thin electrical moped?) (for a review see Loken et al., 2008) or brands and brand extensions (to what extent is a particular product seen as a typical member of the brand family, and to what extent do favourable brand attitudes extend to a particular product? See Broniarczyk & Alba, 1994). Although brands are intangible in themselves, they are typically represented by a logo and their product family. The current research shows that the mechanisms of categorization and attitude extension can even prevail with completely abstract concepts.

Studies on social prejudice form another field of research related to categorization theory. In fact, the best way to describe the process by which the evaluations towards genomics were reached is by the term *prejudice*. Prejudice, the name coming from ‘pre-judgment’, is now virtually exclusively used for social prejudice. Yet, when we look at the mechanism behind social prejudice and the mechanism found in this dissertation, the process of reaching evaluations is the same. Social prejudice deals with social categorization (the perceived group membership) of an individual in a social category (for example, race), resulting in a prejudice using the attitudes and beliefs relating to the social category (see Allport, 1954). In this research, a similar process was found, with unfamiliar technologies being categorized in a conceptual category, to be evaluated on beliefs and attitudes towards that category. Because of the similarities, social prejudice theory may enhance the understanding of how people reach an evaluation of technologies.

Practical implications

The results show that the name of a technology can have an important influence on its evaluation. The effects of a name can occur at different levels of intensity of public science communication, ranging from the public being merely exposed to a name, through interpreting responses about a technology, to interactive discussions with the public. The pivotal influence on public opinions resulting from exposure to a name is discussed first, followed by the importance of realizing that a name can determine reactions in debates with the public. How categorization theory can be used to change perceptions about the technical nature in direct debates is discussed thereafter.

Oftentimes, the current work has been misinterpreted as a marketing ploy to propel acceptance of genomics by avoiding controversies surrounding GM rather than studies to enhance insight into the formation of emerging perceptions and attitudes. These concerns are addressed in concluding remarks about the practical limitations, not only to emphasize the goal of understanding the formation of perceptions and attitudes, but to also show potential side-effects that can be regarded as unfavourable when the aim is merely to get genomics accepted without question or debate.

Attention to the name

First and foremost, the results show that it is important to pay attention to the name. According to Dancygier and Sweetser (2014), a name is given to a conceptual structure when it is used recurrently by the users of the name. This means not only that scientists are at the forefront of shaping names as they are the ones who need to refer to the conceptual structures first, but also that the names that they create refer to *their* conceptual structures. As this dissertation shows, when people lack the appropriate conceptual structures, other structures are activated by the name, making it miss its purpose. Selecting a ‘public’ name instead of using a name used and understood only by experts can prevent this from happening.

To make the process of selecting a name as successful as possible, it is beneficial to realize that a name is not an arbitrary label; rather, it should be treated as a tool to activate knowledge structures between people that are communicating. In addition, an expert’s view of a subject is fundamentally different from the view of someone lacking expertise, with the emphasis on *different*. Experts tend to assume that their knowledge is more developed and that they can approximate the position of laypeople by using less of their knowledge (Mogendorff, Te Molder, Gremmen, & Van Woerkum, 2012). However, knowledge development is not only about more knowledge, it is also about reorganizing knowledge. Therefore, it has a different shape and is not necessarily easily transformed back into a lay perspective. It is actually very difficult to understand how someone with less knowledge understands. Lastly, it is important to realize that the difference in knowledge cannot be taken away with minor public education. Even if it could, reaching everyone would be impossible, and most people will therefore be forced to interpret information and make decisions using their far less developed cognitive structures.

Because experts and the public may be too far apart, it is recommended to pursue the development of a name with the aid of social scientists. Most importantly, it should be done in interaction with the public, so that their world view can be taken into account. In effect, selecting a name can best be approached as an act of co-creation between experts and the public. It is recommended that first a group of participants should work on exploring and finding associations that can work and to subsequently test these with a new group of participants.

This advice is especially important when it is realized that there will be very limited if any contact with the public. Feedback from the public will therefore be minimal, just as opportunities to explain. However, realizing the way people base their perception on a name is also helpful when public responses do reach stakeholders and stakeholders are trying to interpret these responses.

Interpreting public responses

In the debate relating to genomics, it is important to realize that many opinions might result from the idea that genomics is GM. Consequently, objections to it and support for it might actually not be related to genomics itself. Given the controversial nature of GM, this means that genomics might be rejected by many even though they might actually support the technology on (unknown) technical grounds, or vice versa. The same is true for other innovations where perceptions about associated technologies might influence judgements. Realizing that associations with other controversial technologies might be the cause of controversies about the new innovation can make a difference in many (types of) decisions, such as politicians deciding to invest in research, farmers deciding to reject or adopt cultivars for production, and environmental organizations deciding to discourage or promote support.

In interpreting public responses, it is necessary to keep in mind how people make sense of unfamiliar concepts. In particular, when responses appear to make no sense, experts might find themselves tempted to just dismiss them as misunderstandings or ignorance. In such cases, trying to understand how the responses came about might be a more fruitful strategy for both understanding the responses and preventing similar confusion in the future. From the findings, it is recommended, first of all, to explicitly remind oneself that people will often have very limited theoretical knowledge and follow a path other than seeking education to form perceptions. Then, investigating whether the public responses can be explained as based on concepts that appear similar in any way (for example, form, shape, or name) to the one being communicated about can prove insightful for discovering how people shape their opinions. Investigating the extent to which the confusion might have been inadvertently encouraged by one's own way of communicating might be a beneficial step towards preventing further confusion by changing, for example, the name or even correcting perceptions when public interaction does take place.

How to possibly correct misperceptions is briefly discussed next, but it must be stressed that it is imperative for the current advice to be implemented for the right reasons and executed with great sensitivity. The advice given should not be used as a way to delegitimize concerns just to enhance reported public support and make it appear stronger (see also section Concluding remarks about the practical implications, later in this chapter). Quite apart from its questionable morality, it is strongly advised not to delegitimize public concerns, because doing so may have negative effects on future public support for the innovation and even science and technology in general. Delegitimizing concerns backfires and does considerable harm in the long run; a lack of public trust in the willingness of the scientific community to accept public concerns is often quoted as a cause of, or a significant contributor to, the controversies relating to science and technology (Bauer, 2009, 2016; Bauer et al., 2007; Brunk, 2006), and the feeling of not being taken seriously is an important factor (Wynne, 1996, 2001; Irwin & Michael, 2003; see also Irwin, 2001 on appreciation for being taken seriously). In fact, trust, or a lack thereof, in the scientific community can even serve as an alternative to knowledge for judging a technology (Siegrist, 2000; Siegrist, Keller, & Kiers, 2005; Sjöberg, 2001).

Interventions when public interaction does take place

Categorization theory and Piaget's related theory on genetic epistemology can help correct misunderstandings in situations where direct contact and debate do take place. According to Piaget's theory of genetic epistemology, people assimilate new concepts without changing their knowledge structure. People will continue to use this organization of knowledge until they run into trouble, at which point they reorganize their knowledge (Piaget & Cook, 1952). Consequently, it is recommended to explain theoretical concepts targeting these conflicts. People can be forced to reconsider their initial categorization if information is provided that conflicts with their knowledge structure.

Forcing others to change their knowledge structure can be difficult. People especially notice and appreciate information fitting their expectations. To notice information that is in conflict with one's expectations, one needs to pay careful attention; and people will still be prone to try to confirm their initial categorization (Fiske & Neuberg, 1990; Michaut, 2004). Personal relevance is an important aspect that can help motivate people to pay the attention required (Fiske & Neuberg, 1990). Therefore, providing information that is in conflict with a person's ideas is more effective if the topic's personal relevance to the person is stressed.

A complicating factor in trying to change perceptions is that, as mentioned earlier, people use category-based information to judge a scientific concept especially when they lack detailed theoretical knowledge. Therefore, it might be very difficult to provide conflicting theoretical information, even in public interactions.

Concluding remarks about the practical implications

As stated in Chapter 1, the development of the subtheme, public understanding of science, has been marked by a power struggle between experts and the public. In this struggle, experts have often tried to correct wrong attitudes and disqualify unfavourable opinions as misguided or ignorant (Ahteensuu, 2012; Bucchi, 2008; Wynne, 2005). Some aspects of the recommendations show similarities with claims that the public are not able to make correct evaluations. Consequently, the current research has caused debate about the extent to which it supports the view that the public are not able to understand properly, and the proposal to use meaningful names has been interpreted as a marketing ploy with no other purpose than to prevent controversies in several debates. This, however, is not the case.

The notion that the public misunderstand goes beyond the traditional view that they are ignorant and too lazy to take an interest, as described by Bucchi (2008). First and foremost, the idea that the public can possibly misunderstand is rooted in the idea that there is a knowledge gap between the public and experts. Rather than calling for the exclusion of the public, the advice is to try to bridge the gap and prevent misunderstandings by finding meaningful associations.

Second, the advice given is not about preventing controversies or rejection; rather, it is about promoting a correct imagination of what a concept might be. The aim is to achieve a form of communication that makes the public realize the unique aspects of scientific constructs. Certainly, this might prevent certain controversies, yet leave room for others. To use the example of this dissertation, people treat genomics and GM as being the same thing. Although this indicates that genomics would be evaluated more favourably if it were not associated with GM (based on the finding that natural crossing causes more favourable attitudes), other potentially controversial aspects could also be salient. By not recognizing the unique features of genomics, people also do not recognize the unique threats of genomics. For example, the ability to read DNA in detail can have severe impacts on how we live our lives. Plant genomics can propel human genomics given that the investment in technologies can be used for both, making them both more affordable and reachable. Therefore, plant genomics might contribute to developments that are deemed unethical by many, such as a eugenics society and genetic screening by insurance companies. If the difference between GM and genomics is made clear, the public might be able to make better decision about a broader set of consequences. Thus, finding meaningful names is not about blinding the public from important issues; rather, it is about enhancing the chances that they will realize the unique benefits and risks of the subject.

Limitations and further research

The aim of the current dissertation was to explore the influence of a name on the interpretation of the technology it represents. To my knowledge, the research is one of the first of its kind and has several limitations. First and foremost, the research was inspired by reports by scientists working on genomics noting confusion with GM. Consequently, its findings are primarily about the categorization of genomics with GM because of the name similarity. Exposing respondents to other plant breeding practices (GM and traditional breeding, respectively) made it possible to determine the commonalities of their evaluations with those for genomics. Consequences of this explicit mental activation of these plant breeding practices are discussed next. This section concludes by focusing on limitations resulting from the attention paid to attitudes in their initial stage and recommendations for further research.

Categorizations of other technologies

Genomics and GM share not only similarities in name, but also many technological similarities. Although there is an important defining difference between the technologies with respect to artificial recombination, which is the key in many controversies surrounding GM, the approaches do share many of the theories and practices behind them. This is especially important with respect to the finding reported in Chapter 5 that providing information does not influence the evaluation strategy. The resulting question relates to the extent to which genomics is too similar to GM to make people notice the difference, and whether technologies that are further apart will be categorized together based on the name.

Part of the answer can be found in the results. First of all, as already mentioned, reports exist that nanotechnology suffers from associations with asbestos (Kampers, 2009). In addition, the results show that the name natural crossing can trigger categorization with traditional breeding, even though these names are not as similar as genomics and GM. Consequently, the current research provides initial proof that categorization can prevail even if the names are phonetically different but do represent a common notion. Moreover, when natural crossing was described in Chapter 5 with the characteristics of genomics but paired with traditional breeding, the attitudes towards traditional breeding where the main predictor of attitudes towards natural crossing, showing that the commonalities between genomics and GM might have only a limited influence on the process of attitude extension.

Nevertheless, with the attention on genomics, it is clear that the direct proof of the effects of a technological name is especially related to that topic. It can therefore be recommended to expand the research to other technologies. The subject of nanotechnology, in particular, seems a suitable candidate because of reports by scientists that a similar process appears to be at work. In addition, it would be especially interesting for future research to focus on categorization based on associations that do not appear to be similar in name but, rather, similar in the feelings and images created by a name, such as was done in this research with natural crossing and traditional breeding. Studying in what way categorization operates based on these associations would be particularly interesting not only because most technologies do not share a very similar name but also because people oftentimes only act on these broader associations.

Spontaneous formation of associations

With respect to the central topic of genomics, a limitation in the current research is that the presentation of genomics was combined with the presentation of a familiar technology. The research was designed to confirm or disprove beliefs that people treated genomics and GM as similar concepts and used their ideas about GM to evaluate genomics, as reported by experts. To investigate this, respondents in the related conditions were asked about their opinions on GM after they had read about it, for two reasons. First, it was necessary to evaluate both of these practices to be able to establish whether people did indeed treat them as similar. Second, the goal was to activate existing cognition on GM in order to see how that would be transferred to genomics. Consequently, the research was especially designed to investigate the overlap between attitudes. This was achieved, however, at the expense of being able to investigate how spontaneously the association with GM was formed.

The approach followed provides proof that people spontaneously categorize genomics with GM nevertheless. The evidence can be found in the experimental conditions where people were confronted with the name genomics in combination with a description of traditional breeding. In these conditions, the attitude towards genomics was similar to the attitudes to both genomics and GM in other experimental conditions. In these conditions, the name GM was not mentioned, nor was any information about GM provided. As GM was not part of the procedure, it cannot be proved directly that the attitudes are still based on attitudes towards GM. Nevertheless, the results indicate that people use their attitudes towards GM to evaluate genomics. The genomics evaluation pattern shows similar results in averages and range for respondents in the condition where genomics was paired with traditional breeding and in the condition where genomics was paired with GM. In future research, this could be investigated more directly by using more qualitative research investigating arguments behind the attitudes towards genomics and GM, measured at different sessions to prevent respondents from noticing the relation. Whether or not people spontaneously judge genomics based on their ideas about GM can then be determined more directly by looking at the similarities between arguments.

In this research, we explored the effect of the name genomics by comparing it with the name effect of the possible alternative name natural crossing. This name was selected with the idea in mind that it emphasized a key difference between GM and genomics. However, it is important to note that the name was selected from a methodological perspective rather than from the perspective of a proper alternative that could be used in practice. The fact that the name natural crossing succeeded in showing that people used categorization using a name to evaluate an unfamiliar technology does not automatically mean that it would also serve as a proper alternative for the name genomics in communications about the technology. For example, the current research did not investigate the extent to which people would object to using the name natural crossing to label (a technology with the technological attributes that the technology now known as) genomics (for example because of the previously mentioned possible contribution to a genomics society). Therefore, the previous advice to investigate the effects of a name still stands in the case of genomics.

Subsequent attitude development

Another limitation of the research can be found in relation to the attention to a person’s initial evaluation. The main question answered by the research is: Where do the initial attitudes come from? An interesting question is what the effect of the name is on the development of attitudes. Previous research has shown that generally the valence of attitudes towards food production technologies remains unaffected when information about the risks and benefits is provided (Fischer, Van Dijk, de Jonge, Rowe, & Frewer, 2013; Frewer, Howard, & Shepherd, 1998; Lusk et al., 2004; Scholderer & Frewer, 2003; Van Dijk, Fischer, De Jonge, Rowe, & Frewer, 2012). On the basis of these findings, the unfavourable initial attitudes towards genomics will be very difficult to change even when information is provided. However, the emphasis of the abovementioned research is on the persuasive influence of risk and benefit information rather than on information about the technical nature of the technologies. In the case of genomics, interventions could especially target assumptions about its relation to GM in attempts to establish re-categorization. A study in which focus groups actively debated a technological description provided about genomics showed that three out of four groups eventually concluded that genomics was closely related to traditional breeding even though they initially judged it to be similar to GM (Van den Heuvel et al., 2008). These findings show great similarity to the case where organic farmers changed their view after debating with experts and that perceptions about what genomics entails (especially in relation to GM) can be changed. It would be interesting to see whether such categorization also means that attitudes are reconstructed. If so, it can make the difference between choosing to inform the public about differences from GM and choosing to inform them about the risks and benefits. Although the wider public will probably never engage in such intimate meeting with experts, such insights could prove beneficial especially in dealings with stakeholders where there is time to provide information.

Conclusions

The aim of the dissertation was to gain insights into how and why people quickly formed perceptions that were difficult to change about a technology after being exposed to its name. On the premise that man is a rational actor, this kind of behaviour seems irrational, especially to experts who use their theoretic knowledge to judge a technology. A view commonly held by experts is that these kinds of irrational beliefs should be corrected through education, and not taken seriously when important decisions are being made about the development of a technology.

Experts appear to underestimate the impact of their knowledge on their daily decision making regarding the subject of their expertise. Non-experts have to reach quick and non-educated conclusions to function in the modern world; it is impossible to allocate the time and effort to reach the level of expert in all technological innovations encountered. Instead of getting detailed related knowledge through education, people need to reach evaluations and conclusions quickly and efficiently. One way of doing so is by categorizing new unfamiliar concepts with familiar ones and using knowledge about the latter to make decisions about the first. The reason why a name has such a strong impact on the formation of perceptions is that it influences the categorization process. As many technological and scientific concepts are completely intangible, the name will often be the most pronounced aspect to be used for the categorization process.

An important question addressed in this dissertation is whether a name alone would indeed convince people enough to make an evaluation. The results show that it does. Instead of reaching random or neutral evaluations about genomics after reading only the name without any further technical information, people virtually universally judged this unfamiliar technology using their perceptions about GM after categorizing them together. An alternative hypothetical name stressing the more traditional aspects of genomics breeding (natural crossing) caused categorization with the more favourably evaluated breeding practice traditional breeding, leading to more favourable evaluations. Noticeably, these patterns remained intact after provision of the exact same technical information in combination with these names; genomics was evaluated as similar to GM, and natural crossing was still evaluated as similar to traditional breeding. Therefore, the results show not only that a name is enough to trigger a response, but also that providing technical information does not necessarily prevent people from using the name to reach an evaluation. In all likelihood, people use their activated categories to interpret the information given. In other words, the name acts as a frame.

These findings show how important it is to carefully consider the name of a technology. A name can have a pivotal effect on the public's perception through the way it gives meaning to otherwise completely abstract concepts. Much of the public education about science and technology attempts to influence perceptions by providing information. However, once perceptions are activated through a name, these perceptions can actually be used to interpret provided information. Although this does not mean that it impossible to change perceptions, it does make it very hard to do so. Thinking ahead about what effects a name can have on perceptions of a technology and selecting a name that creates the right impressions can be of immense importance in getting the right idea across, more quickly and efficiently.

References

Acquaah, G. (2007). *Principles of plant genetics and breeding*. Oxford, UK: Blackwell Publishing.

Ahteensuu, M. (2012). Assumptions of the deficit model type of thinking: Ignorance, attitudes, and science communication in the debate on genetic engineering in agriculture. *Journal of Agricultural Ethics*, *25*(3), 295–313.

Alba, J. W., & Hutchinson, J. W. (1987). Dimensions of consumer expertise. *Journal of Consumer Research*, *13*(4), 411–454.

Albar, F. M., & Jetter, A. J. (2009). Heuristics in decision making. In *Proceedings of PICMET 2009: Technology management in the age of fundamental change*, pp. 578–584. Portland, OR.

Albarracín, D., Zanna, M. P., Johnson, B. T., & Kumkale, G. T. (2005). Attitudes: Introduction and Scope. In D. Albarracin, B. Johnson, & M. Zanna (Eds.), *The handbook of attitudes* (pp. 3-19). Mahwah, NJ: Erlbaum.

Allard, R. W. (1999). *Principles of plant breeding*. New York, NY: John Wiley.

Allport, G. W. (1954). *The nature of prejudice*. Reading, MA: Addison-Wesley.

Anderson, J. R. (2009). *Cognitive psychology and its implications*. New York, NY: Worth.

Aron, A., Aron, E. N., & Smollan, D. (1992). Inclusion of Other in the Self Scale and the structure of interpersonal closeness. *Journal of Personality and Social Psychology*, *63*, 596–612.

Bánáti, D. (2011). Consumer response to food scandals and scares. *Trends in Food Science & Technology*, *22*(2), 56–60.

Bargh, J. A. (2002). Losing consciousness: Automatic influences on consumer judgement, behavior and motivation. *Journal of Consumer Research*, *29*, 280–285.

Barnes, B., & Dupré, J. (2009). *Genomes and what to make of them*. Chicago, IL: University of Chicago Press.

Barsalou, L. W. (1985). Ideals, central tendencies, and frequency of instantiation as determinants of graded structure in categories. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 11, 629–654.

Barsalou, L.W. (1991). Deriving categories to achieve goals. In G. H. Bower (Ed.), *The psychology of learning and motivation: Advances in research and theory* (Vol. 27, pp. 1–64). San Diego, CA: Academic Press.

Batra, R., & Ahtola, O. T. (1991). Measuring the hedonic and utilitarian sources of consumer attitudes. *Marketing Letters, 2*(2), 159–170.

Bauer, M. W. (2009). The evolution of public understanding of science – Discourse and comparative evidence. *Science, Technology and Society*, *14*(2), 221–240.

Bauer, M. W. (2016). Results of the essay competition on the 'deficit concept'. *Public Understanding of Science*, *25*(4), 398–399.

Bauer, M. W., Allum, N., & Miller, S. (2007). What can we learn from 25 years of PUS survey research? Liberating and expanding the agenda. *Public Understanding of Science*, *16*(1), 79–95.

Bauer, M., Durant, J., & Gaskell, G. (1998). Biology in the public sphere: A comparative review. In J. Durant, M. Bauer, & G. Gaskell (Eds.), *Biotechnology in the public sphere* (pp. 217–227). London, UK: Science Museum.

Bodmer, W.F. (1985). *The public understanding of science*. London, UK: The Royal Society.

Borlaug, N. E. (1968, August). *Wheat breeding and its impact on world food supply*. Paper presented at the International Wheat Genetics Symposium 3, Canberra. Canberra, Australia: Australian Academy of Science.

Bos, M. J. W., Koolstra, C. M., & Willems, J. (2009). Adolescent responses toward a new technology: First associations, information seeking, and affective responses to ecogenomics. *Public Understanding of Science, 18*(2), 243–253.

Bos, M. J., Koolstra, C. M., & Willems, J. T. (2010). Early exposures to ecogenomics: Effects of priming and web site interactivity among adolescents. *Science Communication, 32*(2), 232–255.

Boyer, J. S. (1982). Plant productivity and environment. *Science*, *218*(4571), 443–448.

Bredahl, L., Grunert, K. G., & Frewer, L. J. (1998). Consumer attitudes and decision-making with regard to genetically engineered food products–a review of the literature and a presentation of models for future research. *Journal of Consumer Policy*, *21*(3), 251–277.

Breseghello, F., & Coelho, A. S. G. (2013). Traditional and modern plant breeding methods with examples in rice (Oryza sativa L.). *Journal of Agricultural and Food Chemistry*, *61*(35), 8277–8286.

Broniarczyk, S. M., & Alba, J. W. (1994). The importance of the brand in brand extension. *Journal of Marketing Research, 31*(May), 214–228.

Brunk, C. G. (2006). Public knowledge, public trust: Understanding the 'knowledge deficit'. *Public Health Genomics*, *9*(3), 178–183.

Bucchi, M. (2008). Of deficits, deviations and dialogues: Theories of public communication of science. In M. Bucchi & B. Trech (Eds.), *Handbook of public communication of science and technology* (pp. 57–76). New York, NY: Routledge.

Chaiken, S. (1980). Heuristic versus systematic information processing and the use of source versus message cues in persuasion. *Journal of Personality and Social Psychology*, *45*, 241–256.

Chaiken, S., & Trope, Y. (Eds.). (1999). *Dual-process theories in social psychology*. New York, NY: Guilford Press.

Chen, S., Duckworth, K., & Chaiken, S. (1999). Motivated heuristic and systematic processing. *Psychological Inquiry*, *10*(1), 44–49.

Christie, M. (2001). *The ozone layer: A philosophy of science perspective*. Cambridge, UK: Cambridge University Press.

Cobb, M. D., & Macoubrie, J. (2004). Public perceptions about nanotechnology: Risks, benefits and trust. *Journal of Nanoparticle Research*, *6*(4), 395–405.

Collard, B. C., & Mackill, D. J. (2008). Marker-assisted selection: An approach for precision plant breeding in the twenty-first century. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *363*(1491), 557–572.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological review*, *82*(6), 407.

Concise Oxford Dictionary of Current English. (1990). Cultivar. Oxford, UK: Clarendon Press.

Conway, E. (2008, May 12). *What's in a name? Global warming vs. climate change.* Retrieved from http://www.nasa.gov/topics/earth/features/climate_by_any_other_name.html

Cook, G. (2004). *Genetically modified language: The discourse of arguments for GM crops and food*. New York, NY: Routledge.

Cook, G., Pieri, E., & Robbins, P. T. (2004). 'The scientists think and the public feels': Expert perceptions of the discourse of GM food. *Discourse & Society*, *15*(4), 433–449.

Corbett, J. B., & Durfee, J. L. (2004). Testing public (un)certainty of science: Media representations of global warming. *Science Communication*, *26*(2), 129–151.

Cramer, D., & Howitt, D. L. (2005). *The Sage dictionary of statistics: A practical resource for students in social sciences*. London: Sage.

Currall, S. C., King, E. B., Lane, N., Madera, J., & Turner, S. (2006). What drives public acceptance of nanotechnology? *Nature Nanotechnology*, *1*, 153–155.

Dalal, M., Dani, R. G., & Kumar, P. A. (2006). Current trends in the genetic engineering of vegetable crops. *Scientia Horticulturae*, *107*(3), 215–225.

Dancygier, B., & Sweetser, E. (2014). *Figurative language*. Cambridge, UK: Cambridge University Press.

Davies, S. R. (2008). Constructing communication: Talking to scientists about talking to the public. *Science Communication*, *29*(4), 413–434.

Davison, J. (2010). GM plants: Science, politics and EC regulations. *Plant Science*, *178*(2), 94–98.

De Liver, Y., van der Pligt, J., & Wigboldus, D. (2005). Unpacking atitudes towards genetically modified food. *Appetite*, *45*(3), 242–249.

Decker, M. & Ladikas, M. (eds) (2004). Bridges between Science, Society and Policy. Technology Assessment Methods and Impacts. *Wissenschaftsethik und Technikfolgenbeurteilung Band 22*. Berlin: Springer.

Dijkstra, A. M., & Gutteling, J. M. (2012). Communicative aspects of the public–science relationship explored: Results of focus group discussions about biotechnology and genomics. *Science Communication*, *34*(3), 363–391.

Durant, J. (1999). Participatory technology assessment and the democratic model of the public understanding of science. *Science and Public Policy*, *26*(5), 313–319.

Dutton, J. E., & Jackson, S. E. (1987). Categorizing strategic issues: Links to organizational action. *Academy of Management Review*, *12*(1), 76–90.

Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes*. Fort Worth, TX: Harcourt Brace Jovanovich College Publishers.

Edmeades, G. O., McMaster, G. S., White, J. W., & Campos, H. (2004). Genomics and the physiologist: Bridging the gap between genes and crop response. *Field Crops Research*, *90*(1), 5–18.

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*, *100*(3), 363–406.

European Commission (2010). *Eurobarometer 73.1*. Retrieved from http://ec.europa.eu/public_opinion/archives/ebs/ebs_341_en.pdf

Fabrigar, L. R., MacDonald, T. & Wegener, D. T. (2005). The structure of attitudes. In D. Albarracin, B. Johnson, & M. Zanna (Eds.), *The handbook of attitudes* (pp. 79-124). Mahwah, NJ: Erlbaum.

Faunce, T., Murray, K., Nasu, H., & Bowman, D. (2008). Sunscreen safety: The precautionary principle, the Australian therapeutic goods administration and nanoparticles in sunscreens. *NanoEthics*, *2*(3), 231–240.

Federici, V. (2010). Genetically modified food and informed consumer choice: Comparing US and EU labeling laws. *Brooklyn Journal of International Law*, *35*, 515–561.

Ferguson, M. J., & Bargh, J. A. (2004). How social perception automatically influences behavior. *Trends in Cognitive Sciences*, *8*, 33–39.

Fischer, A. R., van Dijk, H., de Jonge, J., Rowe, G., & Frewer, L. J. (2013). Attitudes and attitudinal ambivalence change towards nanotechnology applied to food production. *Public Understanding of Science*, *22*(7), 817–831.

Fiske, S. T., & Neuberg, S. L. (1990). A continuum of impression formation, from category-based to individuating processes: Influences of information and motivation on attention and interpretation. *Advances in Experimental Social Psychology*, *23*, 1–74.

Fiske, S. T., & Taylor, S. E. (1991). *Social cognition* (2nd ed.). New York, NY: McGraw-Hill.

Frewer, L. J., & Shepherd, R. (1995). Ethical concerns and risk perceptions associated with different applications of genetic engineering: Interrelationships with the perceived need for regulation of the technology. *Agriculture and Human Values*, *12*(1), 48–57.

Frewer, L. J., Howard, C., & Shepherd, R. (1997). Public concerns in the United Kingdom about general and specific applications of genetic engineering: Risk, benefit, and ethics. *Science, Technology & Human Values*, *22*(1), 98–124.

Frewer, L. J., Howard, C., & Shepherd, R. (1998). The influence of initial attitudes on responses to communication about genetic engineering in food production. *Agriculture and Human Values*, *15*(1), 15–30.

Frewer, L. J., Howard, C., Hedderley, D., & Shepherd, R. (1997). Consumer attitudes towards different food-processing technologies used in cheese production – The influence of consumer benefit. *Food Quality and Preference*, *8*(4), 271–280.

Frewer, L. J., Shepherd, R., & Sparks, P. (1994). Biotechnology and food production: Knowledge and perceived risk. *British Food Journal*, *96*, 26–32.

Friedrich, B (2016, September). Clean meat: The “clean energy” of food. *Huffington Post*. Retrieved from http://www.huffingtonpost.com/entry/clean-meat-the-clean-energy-of-food_us_57cee00ee4b0f831f705a879

Gentner, D. (1983). Structure-mapping: A theoretical framework for analogy. *Cognitive Science*, 7, 155–170.

Gepts, P. (2002). A comparison between crop domestication, classical plant breeding, and genetic engineering. *Crop Science*, *42*(6), 1780–1790.

Gigerenzer, G., & Brighton, H. (2009). Homo heuristicus: Why biased minds make better inferences. *Topics in Cognitive Science*, *1*(1), 107–143.

Gigerenzer, G., & Gaissmaier, W. (2011). Heuristic decision making. *Annual Review of Psychology*, *62*, 451–482.

Gregan-Paxton, J. (2001). The role of abstract and specific knowledge in the formation of product judgments: An analogical learning perspective. *Journal of Consumer Psychology*, *11*(3), 141–158.

Gregan-Paxton, J., & John, D. R. (1997). Consumer learning by analogy. A model of internal knowledge transfer. *Journal of Consumer Research*, *24*(3), 266–284.

Gregan-Paxton, J., Hoeffler, S., & Zhao, M. (2005). When categorization is ambiguous: Factors that facilitate the use of a multiple category inference strategy. *Journal of Consumer Psychology*, *15*(2), 127–140.

Gregory, J., & Lock, S. J. (2008). The evolution of ‘public understanding of science’: Public engagement as a tool of science policy in the UK. *Sociology Compass*, *2*(4), 1252–1265.

Gregory, J., & Miller, S (1998). *Science in public: Communication, culture and credibility.* New York, NY: Plenum.

Gremmen, H. G. J. (2007). *De zwakste schakel: over maatschappelijk verantwoorde genomics*. Wageningen, the Netherlands: Wageningen UR.

Gruère, G.P, & Rao, S.R. (2007). A review of international labeling policies of genetically modified food to evaluate India’s proposed rule. *AgBioForum*, *10*(1), 51–64.

Grundmann, R. (2002). *Transnational environmental policy: Reconstructing ozone*. London, UK: Routledge.

Grunert, K. G., Bredahl, L., & Scholderer, J. (2003). Four questions on European consumers’ attitudes toward the use of genetic modification in food production. *Innovative Food Science & Emerging Technologies*, *4*(4), 435–445.

Gupta, N., Fischer, A. R., & Frewer, L. J. (2012). Socio-psychological determinants of public acceptance of technologies: a review. *Public Understanding of Science*, *21*(7), 782-795.

Gutteling, J. M. (2002). Biotechnology in the Netherlands: Controversy or consensus. *Public Understanding of Science*, *11*, 131-142.

Hall, R. (2010). CBSG2012 A public-private partnership in the plant sciences. In H. Zwart (Chair), *CSG Researchers Days 2010*. Symposium organized at the meeting of CSG Centre for Society and the Life Sciences. Berg-en-dal, Netherlands, 3 September.

Hamlett, P. W. (2003). Technology theory and deliberative democracy. *Science, Technology, & Human Values*, *28*(1), 112-40.

Hansen, A. (2010). *Environment, media and communication*. London, UK: Routledge.

Hansen, J., Holm, L., Frewer, L., Robinson, P., & Sandøe, P. (2003). Beyond the knowledge deficit: Recent research into lay and expert attitudes to food risks. *Appetite*, *41*(2), 111–121.

Herr, P. M. (1986). Consequences of priming: Judgement and behavior. *Journal of Personality and Social Psychology*, *51*(6), 1106–1115.

Higgins, E. T. (1989). Knowledge accessibility and activation: Subjectivity and suffering from unconscious sources. In J. S. Uleman & J. A. Bargh (Eds.), *Unintended thought* (pp. 75–123). New York: Guilford Press.

Higgins, E. T. (1996). Knowledge activation: Accessibility, applicability, and salience. In E. T. Higgins & A. W. Kruglanski (Eds.), *Social psychology: Handbook of basic principles* (pp. 133–168). New York: Guilford Press.

Ingold, T., & Kurtilla, T. (2000). Perceiving the environment in Finnish Lapland. *Body & Society*, *6*(3–4), 183–196.

Irwin, A. (2001). Constructing the scientific citizen: Science and democracy in the biosciences. *Public Understanding of Science*, *10*(1), 1–18.

Irwin, A., & Michael, M. (2003). *Science, social theory & public knowledge*. Maidenhead, UK: Open University Press, McGraw-Hill Education.

Janssen, R. (2002, May 3). Eiwitnetwerken. Proteomics is de nieuwe stap in genetisch onderzoek. *NRC Handelsblad*, p. 10.

Jasanoff, S. (2005). *Designs on Nature: Science and Democracy in Europe and the United States*. Princeton: University Press.

Journal of Plant Physiology & Pathology. (n.d.). Plant breeding. Retrieved from https://www.scitechnol.com/plant/plant-breeding.php

Kahneman, D. (2011). *Thinking, fast and slow*. London, UK: Penguin.

Kahneman, D. 2003. Maps of Bounded Rationality: Psychology for Behavioral Economics. *American Economic Review*, *93*(5), 1449-1475.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica: Journal of the Econometric Society, 47*, 263–291.

Kampers, F (2009). *What nanotechnology can do for your average donut*. Retrieved from http://2020science.org/2009/03/30/what-nanotechnology-can-do-for-your-average-donut/

Kanouse, D. E. (1984) ,"Explaining Negativity Biases in Evaluation and Choice Behavior: Theory and Research". In T. C. Kinnear (eds.), *Advances in*

Consumer Research Volume 11 (703-708). Provo, UT : Association for Consumer Research.

Kerschner, C., & Ehlers, M. H. (2016). A framework of attitudes towards technology in theory and practice. *Ecological Economics*, *126*, 139–151.

Kruglanski, A. W., & Webster, D. M. (1996). Motivated closing of the mind: "Seizing" and "freezing". *Psychological Review*, *103*(2), 263–283.

Kruglanski, A. W., Webster, D. M., & Klem, A. (1993). Motivated resistance and openness to persuasion in the presence or absence of prior information. *Journal of Personality and Social Psychology*, *65*(5), 861–876.

Lee, C. J., Scheufele, D. A., & Lewenstein, B. V. (2005). Public attitudes toward emerging technologies: Examining the interactive effects of cognitions and affect on public attitudes toward nanotechnology. *Science Communication*, *27*(2), 240–267.

Löfstedt, R. (2005). *Risk management in post-trust societies*. New York, NY: Palgrave Macmillan.

Loken, B., Barsalou, L. W., & Joiner, C. (2008). Categorization theory and research in consumer psychology: Category representation and category-based inference. In C. P. Haugtvedt, P. M. Herr, & F. R. Kardes (Eds.), *Handbook of consumer psychology* (pp. 133–163). New York: Lawrence Erlbaum Associates.

Lusk, J. L., House, L. O., Valli, C., Jaeger, S. R., Moore, M., Morrow, J. L., & Traill, W. B. (2004). Effect of information about benefits of biotechnology on consumer acceptance of genetically modified food: Evidence from experimental auctions in the United States, England, and France. *European Review of Agricultural Economics*, *31*(2), 179–204.

Macoubrie, J. (2008). Informed public perception of nanotechnology and trust in government. Woodrow Wilson International Center for Scholars, Project on Emerging Nanotechnologies. Retrieved from: http://www.nanotechproject.org/process/files/2709/8_informed_public_perceptions_of_nanotechnology_and_trust_in_government.pdf

Mammoser, G (2016, October). Why the meat factories of the future will look like breweries. *Munchies*. Retrieved from https://munchies.vice.com/en/articles/why-the-meat-factories-of-the-future-will-look-like-breweries

Maranta, A., Guggenheim, M., Gisler, P., & Pohl, C. (2003). The reality of experts and the imagined lay person. *Acta Sociologica*, *46*(2), 150–165.

Marris, C., Wynne, B., Simmons, P., & Weldon, S. (2001). *Public perceptions of agricultural biotechnologies in Europe*. Lancaster, UK: Lancaster University.

Maynard, A. (2008, June). *Testimony by Dr. Andrew Maynard for the U.S. House Committee on Science and Technology*. Retrieved from https://science.house.gov/sites/republicans.science.house.gov/files/documents/hearings/041608_charter.pdf

Meaney, T. F. (1984). Magnetic resonance without nuclear. *Radiology*, *150*(1), 277–277.

Mervis, C. B., & Rosch, E. (1981). Categorization of natural objects. *Annual Review of Psychology*, 32(1), 89–115.

Michaut, A. M. K. (2004). *Consumer responses to innovative products with application to foods*. PhD Thesis. Wageningen, The Netherlands: Wageningen University.

Miller, S. (2001). Public understanding of science at the crossroads. *Public Understanding of Science, 10*(1), 115–120.

Mogendorff, K., Te Molder, H., Gremmen, B., & Van Woerkum, C. (2012). "Everyone may think whatever they like, but scientists…" Or how and to what end plant scientists manage the science–society relationship. *Science Communication*, *34*(6), 727–751.

Mogendorff, K., Te Molder, H., van Woerkum, C., & Gremmen, B. (2015). Turning experts into self-reflexive speakers: The problematization of technical-scientific expertise relative to alternative forms of expertise. *Science communication*, 1075547015615113.

Moreau, C. P., Markman, A. B., & Lehmann, D. R. (2001). "What is it?" Categorization flexibility and consumers' responses to really new products. *Journal of Consumer Research*, *27*(4), 489–498.

Muthukrishnan, A. V., & Weitz, B. A. (1991). Role of product knowledge in evaluation of brand extension. In R. H. Holman & M. R. Solomon (Eds.), *Advances in consumer research* (Vol. 18, pp. 407–413). Provo, UT: Association for Consumer Research.

Nap, J. P. H., Jacobs, J., Gremmen, B., & Stiekema, W. J. (2002). *Genomics and sustainability: Exploring a societal norm* (No. 204). Wageningen, The Netherlands: Plant Research International B.V.

Orbell, J., & Dawes, R. M. (1991). A "cognitive miser" theory of cooperators' advantage. *American Political Science Review*, *85*(2), 515–528.

Pardo, R., Midden, C., & Miller, J. D. (2002). Attitudes toward biotechnology in the European Union. *Journal of Biotechnology*, *98*(1), 9–24.

Petty, R. E., & Cacioppo, J. T. (1986). *Communication and persuasion: Central and peripheral routes to attitude change*. New York: Springer-Verlag.

Petty, R. E., & Cacioppo, J. T. (1986). The elaboration likelihood model of persuasion. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol 19, pp. 123–205). New York, NY: Academic Press.

Piaget, J., & Cook, M. T. (1952). *The origins of intelligence in children*. New York, NY: International University Press.

Pin, R. R., & Gutteling, J. M. (2008). The development of public perception research in the genomics field: An empirical analysis of the literature in the field. *Science Communication*, *31*(1), 57–83.

Poehlman, J. M. (2013). *Breeding field crops*. New York, NY: Springer.

Pohost, G. M., Elgavish, G. A., & Evanochko, W. T. (1986). Nuclear magnetic resonance imaging: With or without nuclear? *Journal of the American College of Cardiology*, *7*(3), 709–710.

Rajagopal, P., & Burnkrant, R. E. (2009). Consumer evaluations of hybrid products. *Journal of Consumer Research*, *36*(2), 232–241.

Rangaswamy, A., Burke, R. R., & Oliva, T. A. (1993). Brand equity and the extendibility of brand names. *International Journal of Research in Marketing*, *10*(1), 61–75.

Rosch, E. (1975). Cognitive representations of semantic categories. *Journal of Experimental Psychology: General*, *104*(3), 192–233.

Rosch, E. (1978). Principles of categorization. In E. Rosch & B. B. Lloyd (Eds.), *Cognition and categorization* (pp. 27–48). Hillsdale, NJ: Lawrence Erlbaum.

Rosch, E., Mervis, C. B., Gray, W. D., Johnson, D. M., & Boyes-Braem, P. (1976). Basic objects in natural categories. *Cognitive Psychology*, *8*(3), 382–439.

Rosch, E., Simpson, C., & Miller, R. S. (1976). Structural bases of typicality effects. *Journal of Experimental Psychology: Human Perception and Performance*, *2*(4), 491–502.

Rousseau, O. (2016, September). Lab-made meat rebranded ‘clean meat’ to address ‘yuck’ factor. *GlobalMeatNews.com*. Retrieved from http://www.globalmeatnews.com/Analysis/Lab-made-meat-rebranded-clean-meat

Rozin, P. (1999). Food is fundamental, fun, frightening, and far-reaching. *Social Research*, *66*, 9-30.

Rozin, P., Spranca, M., Krieger, Z., Neuhaus, R., Surillo, D., Swerdlin, A., & Wood, K. (2004). Preference for natural: instrumental and ideational/moral motivations, and the contrast between foods and medicines. *Appetite*, *43*(2), 147–154.

Sarewitz, D (2004). How science makes environmental controversies worse. *Environmental Science & Policy*, *7*, 385-403.

Saxena, D., Flores, S., & Stotzky, G. (1999). Transgenic plants: Insecticidal toxin in root exudates from Bt corn. *Nature*, *402*(6761), 480.

Scheufele, D. A. & Lewenstein, B. V. (2005). The public and nanotechnology: How citizens make sense of emerging technologies. *Journal of Nanoparticle Research*, *7*(6), 659–667.

Scholderer, J., & Frewer, L. (2003). The biotechnology communication paradox: Experimental evidence and the need for a new strategy. *Journal of Consumer Policy*, *26*, 125–157.

Schultz, D. P., & Schultz, S. E. (2015). *A history of modern psychology*. Boston, MA: Cengage Learning.

Schwarz, N., & Bless, H. (1992). Constructing reality and its alternatives: An inclusion/exclusion model of assimilation and contrast effects in social judgment. In L. L. Martin & A. Tesser (Eds.) The construction of social judgements (pp. 217–245). Hillsdale, NJ: Erlbaum.

Sedikides, C., & Skowronski, J. J. (1991). The law of cognitive structure activation. *Psychological Inquiry*, *2*(2), 169–184.

Shafir, E. (1993). Choosing versus rejecting: Why some options are both better and worse than others. *Memory & Cognition*, *21*(4), 546–556.

Shah, A. K., & Oppenheimer, D. M. (2008). Heuristics made easy: An effort-reduction framework. *Psychological Bulletin*, *134*(2), 207–222.

Shook, N. J., Fazio, R. H., & Eiser, J. R. (2007). Attitude generalization: Similarity, valence, and extremity. *Journal of Experimental Social Psychology*, *43*(4), 641–647.

Siegrist, M. (2000). The influence of trust and perceptions of risks and benefits on the acceptance of gene technology. *Risk Analysis*, *20*(2), 195–204.

Siegrist, M., Cousin, M. E., Kastenholz, H., & Wiek, A. (2007). Public acceptance of nanotechnology foods and food packaging: The influence of affect and trust. *Appetite*, *49*(2), 459-466.

Siegrist, M., Keller, C., & Kiers, H. A. (2005). A new look at the psychometric paradigm of perception of hazards. *Risk Analysis*, *25*(1), 211–222.

Siegrist, M., Keller, C., Kastenholz, H., Frey, S., & Wiek, A. (2007). Laypeople's and experts' perception of nanotechnology hazards. *Risk Analysis*, *27*(1), 59–69.

Siegrist, M., Stampfli, N., Kastenholz, H., & Keller, C. (2008). Perceived risks and perceived benefits of different nanotechnology foods and nanotechnology food packaging. *Appetite*, *51*(2), 283-290.

Simon, H. A. (1955). A behavioral model of rational choice. *The Quarterly Journal of Economics*, *69*(1), 99–118.

Simon, H. A. (1956). Rational choice and the structure of the environment. *Psychological Review*, *63*(2), 129–138.

Simon, H. A. (1979). *Models of thought*. New Haven, CT: Yale University Press.

Simon, H. A. (1990). Invariants of human behavior. *Annual Review of Psychology*, *41*(1), 1–20.

Simon, H. A. (1997). *Models of bounded rationality*. Cambridge, MA: MIT Press.

Simons, J., Zimmer, R., Vierboom, C., Härlen, I., Hertel, R., & Böl, G. F. (2009). The slings and arrows of communication on nanotechnology. *Journal of Nanoparticle Research*, *11*(7), 1555–1571.

Sjöberg, L. (2001). Limits of knowledge and the limited importance of trust. *Risk Analysis*, *21*(1), 189–198.

Skinner, B. F. (2011). *About behaviorism*. New York, NY: Vintage.

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2007). The affect heuristic. *European Journal of Operational Research*, *177*(3), 1333–1352.

Sparks, P., Shepherd, R., & Frewer, L. J. (1994). Gene technology, food production, and public opinion: A UK study. *Agriculture and Human Values*, *11*(1), 19–28.

Steenis, N. D., & Fischer, A. R. (2016). Consumer attitudes towards nanotechnology in food products: an attribute-based analysis. *British Food Journal*, *118*(5), 1254-1267.

Sturgis, P., Brunton-Smith, I., & Fife-Schaw, C. (2010). Public attitudes to genomic science: An experiment in information provision. *Public Understanding of Science*, *19*(2), 166–180.

Tester, M., & Langridge, P. (2010). Breeding technologies to increase crop production in a changing world. *Science*, *327*(5967), 818-822.

Toncar, M., & Munch, J. (2001). Consumer responses to tropes in print advertising. *Journal of Advertising*, *30*(1), 55–65.

Tversky, A., & Kahneman, D. (1982). Judgment under uncertainty: Heuristics and biases. In D. Kahneman, P. Slovic, & A. Tversky (Eds.), *Judgement under uncertainty: Heuristics and biases* (pp. 3–20). Cambridge, UK: Cambridge University Press.

Tversky, A., & Kahneman, D. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty*, *5*(4), 297–323.

Ungar, S. (2000). Knowledge, ignorance and the popular culture: Climate change versus the ozone hole. *Public Understanding of Science*, *9*(3), 297–312.

USDA Foreign Agricultural Service (2010). *Food labelling policy update*. Retrieved from http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Food%20Labeling%20Policy%20Update_Kiev_Ukraine_1-27-2010.pdf

van Aken, J. (2009). *Smart breeding executive summary*. Amsterdam, The Netherlands: Greenpeace International.

Van Dam, F., & De Vriend, H. (2002). *Publieksonderzoek Genomics 2002*. Den Haag, the Netherlands: Stichting Consument en Biotechnologie.

Van den Heuvel, T. (2008). *Consumers & plant genomics*. (Doctoral Dissertation). Wageningen University, Netherlands.

Van den Heuvel, T., Renes, R. J., Gremmen, B., Van Woerkum, C., & Van Trijp, H. (2008). Consumers' images regarding genomics as a tomato breeding technology: "Maybe it can provide a more tasty tomato". *Euphytica*, *Vol 159*(1-2), 207-216.

Van den Heuvel, T., Renes, R. J., Van Trijp, H., Gremmen, B., & Van Woerkum, C. (2008). Consumer judgment regarding genomics: Exploring the influence of initial categorization and different modes of thought. Conference Proceedings. *Etmaal van de Commuicatiewetenschap* 2008. Vrije Universiteit, Amsterdam, 7–8 February.

Van den Heuvel, T., Van Trijp, H., Van Woerkum, C., Renes, R. J., & Gremmen, B. (2007). Linking product offering to consumer needs; inclusion of credence attributes and the influences of product features. *Food Quality and Preference*, *18*(2), 296–304.

Van Dijk, H., Fischer, A. R., De Jonge, J., Rowe, G., & Frewer, L. J. (2012). The impact of balanced risk – Benefit information and initial attitudes on post-information attitudes. *Journal of Applied Social Psychology*, *42*(8), 1958–1983.

Van Giesen, R. I., Fischer, A. R., & Van Trijp, H. C. (2016). Changes in the influence of affect and cognition over time on consumer attitude formation toward nanotechnology: A longitudinal survey study. *Public Understanding of Science*. doi: 10.1177/0963662516661292

Van Giesen, R. I., Fischer, A. R., Van Dijk, H., & Van Trijp, H. C. (2015). Affect and cognition in attitude formation toward familiar and unfamiliar attitude objects. *PloS One*, *10*(10), e0141790.

Van Haperen , P. F., Gremmen, B. & Jacobs, J. (2012). Reconstruction of the ethical debate on naturalness in discussions about plant-biotechnology. *Journal of agricultural and environmental ethics*, *25*(6), 797–812.

Vermeir, I (2003). *The influence of need for closure on consumer behaviour*. (Doctoral Dissertation). Ghent University, Belgium.

Webster, D. M., & Kruglanski, A. W. (1994). Individual differences in the need for cognitive closure. *Journal of Personality and Social Psychology*, *67*(6), 1049–1062.

Wegener, D. T., & Kelly, J. R. (2008). Social psychological dimensions of bioenergy development and public acceptance. *BioEnergy Research*, *1*(2), 107-117.

Whitmarsh, L. (2009). What's in a name? Commonalities and differences in public understanding of "climate change" and "global warming." *Public Understanding of Science, 18*(4), 401–420.

Wright, R. (2006). *Consumer behaviour*. London, UK: Thomson Learning.

Wunderlich, S., & Gatto, K. A. (2015). Consumer perception of genetically modified organisms and sources of information. *Advances in Nutrition: An International Review Journal*, *6*(6), 842–851.

Wyer, R. S. (2014). *The automaticity of everyday life: Advances in social cognition* (Vol. 10). New York, NY: Psychology Press.

Wynne, B. (1993). Public uptake of science: A case for institutional reflexivity. *Public Understanding of Science*, *2*(4), 321–337.

Wynne, B. (1996). May the sheep safely graze? A reflexive view on the expert-lay divide. In S. Lash, B. Szerszynski and B. Wynne (Eds.), *Risk, environment and modernity* (pp. 44–83). London, UK: Sage.

Wynne, B. (2001). Creating public alienation: Expert cultures of risk and ethics on GMOs. *Science as Culture*, *10*(4), 445–481.

Wynne, B. (2005). Reflexing complexity post-genomic knowledge and reductionist returns in public science. *Theory, Culture & Society*, *22*(5), 67–94.

Wynne, B. (2006). Public engagement as a means of restoring public trust in science – Hitting the notes, but missing the music? *Public Health Genomics, 9*(3), 211–220.

Yearley, S. (2000). What does science mean in the "public understanding of science"? In M. Deirkes & C. Von Grote (Eds.), *Between trust and understanding: The public, science and technology* (pp. 151–164). London, UK: Routledge.

Summary

There has been a growing divide between the scientific community and the public. A prominent example of a conflict is the use of Genetic Modification in food products, which led to widespread criticism and a de-facto embargo on products created using GM. In response to the public's criticism scientists started public outreaches. Initially these outreaches were aimed at educating the public and later evolved to asking opinions or offering chances to participate to representatives of the public. Whatever the form of the outreach, communication between scientists and the public intensified and members of the public have to respond to scientific names and terminology they might not understand.

The lack of knowledge about what a name might represent can have far-fetching consequences. A good example is an attempt by genomics scientists to work together with ecological farmers in trying to develop an alternative to GM. Although genomics can provide an alternative to GM for developing new cultivars which circumvents the main objections, the farmers were rejecting cooperation because they inferred that genomics was GM. The scientists reaching out were not only surprised by how quick such inferences were made, but also about how difficult it was to change the resulting perceptions. Similar issues of people drawing incorrect inferences about what a name represents have been reported with other scientific names, including nanotechnology, global warming, and genetic manipulation.

To date, science communication has paid only very limited attention to the effects of scientific language on the impressions by the public. A possible reason is that scientists themselves are largely unaware of how their technical knowledge both enables them to understand scientific language and ask the appropriate questions in attempts to form an understanding. In addition, scientists often still believe that if these kinds of confusions take form, they can be corrected with explanation or education. In everyday life, however, people take split second decisions using quickly formed impressions, and the kind of education that can correct public misunderstandings is actually very rare. In addition, if people develop their

knowledge, what they remember, learn and understand is often largely based on their expectations. A name can therefore have a determining effect not only on quickly formed impressions, but also on more educated ideas.

The effects of difficult to understand names are not limited to public communication. Although misunderstandings are especially noticed during contact, they might even have a bigger impact in situations where there is no contact at all. For example, people might choose to avoid consumer products because of a name triggering unfavourable associations.

The aim of the current dissertation is to systematically investigate the influence of a name on the interpretation and evaluation of a science or technology. It focuses on how people make sense of what a name means and on the subsequent formation of attitudes that occurs when people are confronted with a scientific concept unfamiliar to them. The development of genomics applied to plant breeding is used as case to study the effects of a name on emerging attitudes and understandings.

The research is experimental in nature and in the tradition of cognitive psychology, a sub-discipline of social psychology. Cognitive psychology research predominantly entails experiments that attempt to discover what happens in people's minds when they process information, making it a suitable approach to investigate how people deal with scientific concepts with which they are unfamiliar. Central to cognitive approaches is the notion that people actively process information (such as a name) and that differences in processing can result in differences in outcomes.

Results

In Chapter 2, the aim of the literature study was to discover how initial understanding and attitudes are formed in a situation where a person does not have any knowledge about the topic at hand. Categorization theory describes a process where people place an unfamiliar concept in a category of familiar concepts, which enables them to evaluate the unfamiliar concept by using present knowledge about the familiar concepts. This strategy is simultaneously a way of learning new information and a powerful way of quickly drawing conclusion when knowledge is lacking. It therefor explains both how people are able form their opinions quickly and why they are so hard to change.

In Chapter 3, the aim was to investigate the effects of the name of a technology on uninformed evaluations and decisions using an experiment. The results showed that participants used categorization to reach evaluations and that the name of the technology was used as the basis for the categorization. In addition, the results showed that the unfamiliar concepts were evaluated by applying the pre-existing attitudes linked to the category used for categorization in a sort of copy-and-paste fashion. The result showed that genomics was evaluated similarly to GM, whereas a fictional breeding method called natural crossing was evaluated similarly to traditional breeding.

An additional aim was to investigate the extent to which personal differences might lead to people quickly reaching decisions and evaluations based on categorization. According to theory on need for closure, some people experience a stable high need for closure and want to draw conclusions quickly. Others experience an avoidance of closure and postpone their evaluation until they have the opportunity to study matters further so as to prevent inappropriate conclusions. The results showed, however, that a personal need for closure was unrelated to how quickly people used their associations to reach a conclusion. This can be explained through the fact that someone can prefer conclusions over further elaborate thinking when there is too little information to justify the latter.

In Chapter 4, the aim was to examine the influence of risk perception relating to food on evaluation and categorization. Previous research indicates that GM is perceived as risky and unfavourable, especially when applied to food. The results showed that, in a culture (Ukraine) where GM was perceived as controversial, changing the purpose from food to biofuel resulted in more favourable evaluations of GM, which, in turn, resulted in more favourable evaluations of genomics. However, the effect was absent in the Netherlands, where the average evaluation of GM is neither favourable nor unfavourable, and therefore less controversial. Another effect of perceived risk found in the literature is that risk leads to more perceived similarity. Yet, the results do not indicate a stronger categorization by people with higher risk perceptions. The explanation can be found in the fact that the correlation between the attitudes was very high in the first place. The finding fits the idea that the categorization is realized using the name alone, rather than specific technical details (which had to be present in the mind of the evaluator) that become more important under threat.

In Chapter 5, the purpose was to investigate the influence of activated knowledge on the evaluation of provided information. From the finding in Chapter 2 that categorization provides the basis of learning, it was assumed that, through categorization, the name can have an important impact on learning by determining what information is being noticed, and how it is interpreted and evaluated. The results showed that, when information about genomics was provided, the name used for the technology was still the primary predictor of the evaluations; the presented information did not influence the results to a practical, meaningful extent. Therefore, the results show that the information provided is interpreted using already present knowledge, rather than altering the knowledge and that, therefore, a name can have a long-lasting impact even when learning can potentially take place.

Conclusions

All results show that the name used to describe genomics has a significant impact on how the technology is perceived and evaluated. Virtually unaffected by whether the technology is used for the production of food or biofuel or additional information, people use activated associations to evaluate genomics. The dominating pattern of how the perception of the technology is perceived fits that predicted by categorization theory. When the name used is prone to activating associations with GM, the evaluations are less favourable than when the name used is steering people to using their associations with the more positively considered traditional breeding.

These findings show how important it is to carefully consider the name of a technology. A name can have a pivotal effect on the public's perception through the way it gives meaning to otherwise completely abstract concepts. In numerous cases, people only have these perceptions to act on. In other cases, additional information is provided. However, in situations like these the name still has a strong influence because of the way perceptions are used to interpret the provided information. Although this does not mean that it impossible to change perceptions, it does make it very hard to do so. A well-chosen name can be a very practical tool in getting the right idea across.

Samenvatting

Er is een groeiende kloof tussen wetenschap en samenleving. Een goed voorbeeld is het conflict tussen verschillende groepen over het gebruik van genetische modificatie (GM) in voedselproducten. De wijdverspreide kritiek leidde tot een de-facto embargo op producten die gemaakt zijn met GM. We wetenschap reageerde met publiekscampagnes op de kritiek uit de samenleving op wetenschappelijke ontwikkelingen. In de beginfase waren deze campagnes gericht op het onderwijzen van het publiek. Later kwamen daar initiatieven bij waarin het publiek om meningen werden gevraagd of kansen werd geboden om een bijdrage te leveren aan wetenschappelijke ontwikkelingen. Welke vorm het contact tussen wetenschap en de samenleving ook aannam, communicatie tussen wetenschappers en het publiek intensiveerde en mensen zonder uitgebreide en specialistische wetenschappelijke kennis moeten een reactie zien te formuleren op specialistische wetenschappelijke namen en termen die zij niet altijd volledig begrepen.

Het gebrek aan kennis over wat een naam vertegenwoordigt kan verstrekkende gevolgen hebben. Een goed voorbeeld is een initiatief van genomics-wetenschappers om samen te werken met biologische boeren om een alternatief voor GM te ontwikkelen. Terwijl genomics een alternatief voor GM kan bieden bij het ontwikkelen van nieuwe gewassen, wilde de boeren niet samenwerken met de genomics-wetenschappers omdat zij dachten dat genomics en GM het zelfde betekende. De wetenschappers die de samenwerking zochten waren niet alleen verbaasd over hoe snel de boeren tot dit idee waren gekomen, maar over hoe moeilijk het was om ze er weer van af te krijgen. Bij het communiceren over onder andere nanotechnologie, de opwarming van de aarde en genetische manipulatie rapporteren wetenschappers soortgelijke problemen waarbij mensen snel incorrecte ideeën vormden over de aard van een technologie of wetenschap.

In de wetenschapscommunicatie is tot nu toe zeer weinig aandacht besteed aan de effecten van wetenschappelijke termen op de indrukken en beeldvorming van het publiek. Een mogelijke reden is dat wetenschappers zich niet realiseren in welke mate hun technische kennis ze in staat stelt om zowel wetenschappelijke taal te begrijpen als de juiste vragen te stellen wanneer ze zelf een nieuw wetenschappelijk concept proberen te begrijpen. Daarnaast geloven veel exacte wetenschappers nog steeds dat misverstanden te corrigeren zijn door middel van uitleg en onderwijs. Echter, in het dagelijks leven maken mensen continue snelle beslissing op basis van oppervlakkige indrukken en het type publieke onderwijs dat nodig is om misverstanden te corrigeren is zeer zeldzaam. Daarnaast beïnvloeden verwachting in belangrijke mate hoe individuele kennis ontwikkelt; wat iemand onthoudt, en op welke manier iemand iets interpreteert en begrijpt hangt voor een groot deel af van de verwachting die deze persoon heeft. Hierdoor beïnvloedt een naam niet alleen eerste indrukken maar ook ideeën gevormd op basis van verkregen informatie.

De gevolgen van moeilijk te begrijpen namen zijn niet beperkt tot publieke communicatiecampagnes. Hoewel misverstanden vooral worden opgemerkt wanneer er contact is tussen het publiek en wetenschappers zijn de gevolgen wellicht nog groter wanneer er helemaal geen directe communicatie is. Bijvoorbeeld, consumenten kunnen producten vermijden omdat de naam ervan ongunstige associaties oproept.

Het doel van het huidige onderzoek is om de invloed van een naam op de interpretatie en evaluatie van wetenschappelijke concepten te onderzoeken. De centrale vraag is hoe mensen een voor hen onbekende wetenschappelijke naam proberen te begrijpen en wat voor invloed dit proces heeft op de daarop volgende evaluatie van het concept. Op plantveredeling toegepaste genomics wordt gebruikt als een casus om onderzoek te doen naar de invloeden van een naam op de ontwikkeling van begrip en oordelen.

De centrale vraag wordt onderzocht vanuit de cognitieve psychologie en het onderzoek is experimenteel van opzet. Cognitieve psychologisch onderzoek is hoofdzakelijk experimenteel en heeft doorgaans het doel te onderzoeken op welke manier mensen informatie verwerken, wat het een geschikte theoretische benadring maakt voor het onderzoeken op welke manier mensen omgaan met wetenschappelijke concepten waar ze niet bekend mee zijn. Een belangrijk element van deze cognitieve benadering is de assumptie dat mensen actief bezig zijn met het verwerken van informatie (zoals een naam) en dat verschillende verwerkingsstrategieën kunnen leiden tot verschillen in resultaten.

Onderzoeksresultaten

In Hoofdstuk 2 was het doel van een literatuuronderzoek het beantwoorden van de vraag hoe mensen tot duiding en tot evaluatie komen in een situatie waar zij geen kennis hebben over het centrale onderwerp. Categorisatie Theorie beschrijft een mentaal proces waarbij een onbekend concept in een groep van bekende concepten wordt geplaatst, wat iemand in staat stelt om het onbekende te duiden en te evalueren op basis van de bekende concepten in de groep. Mensen gebruiken deze strategie veelvuldig. Zij leren daarmee nieuwe informatie en kunnen om snel conclusies te trekken wanneer direct gerelateerde kennis ontbreekt. Het verklaart daarmee hoe mensen snel tot een oordeel komen, bovendien blijkt dit oordeel moeilijk te veranderen.

In Hoofdstuk 3 was het doel om door middel van een experiment te onderzoeken welke effecten een wetenschappelijke naam heeft op ongeïnformeerde evaluaties en beslissingen. De resultaten toonden dat deelnemers inderdaad categorisatie gebruikten om tot een oordeel te komen en dat de naam van de technologie de basis voor de categorisatie vormde. Daarnaast lieten de resultaten zien dat de onbekende technologie werd beoordeeld door het oordeel van de bekende categorie-genoten over te nemen en op het nieuwe concept ‘te plakken’. De resultaten toonden dat genomics hetzelfde werd beoordeeld als GM, terwijl de fictieve naam ‘natuurlijk kruizen’ leidde tot een beoordeling die gelijk was aan traditionele veredeling.

Een ander doel was om te onderzoeken in welke mate persoonlijke verschillen een rol spelen in het snel trekken van conclusies. Volgens de ‘Need for Closure’- Theorie hebben sommige mensen een sterke behoefte om snel tot een oordeel te komen. Anderen hebben juist de behoefte om hun oordeel uit te stellen tot ze kans hebben gehad om een onderwerp beter te bestuderen in een poging om onjuiste conclusies te voorkomen. De resultaten toonden echter dat mate van ‘need for closure’ geen invloed had op de manier waarop mensen hun associaties gebruikten om tot een oordeel te komen. Een verklaring voor deze bevinding is dat iedereen genoodzaakt is om zo nu en dan snel een oordeel te vormen en het gebruik van een mentaal proces van categorisatie daarbij universeel is.

Het doel van Hoofdstuk 4 was te onderzoeken in welke mate aan voedsel gerelateerde risicopercepties een rol spelen bij categorisatie en evaluatie. Eerder onderzoek wijst erop dat GM vooral als risicovol en ongunstig wordt beoordeeld wanneer de technologie wordt gebruikt voor het vervaardigen van voedsel. De resultaten van het huidige onderzoek tonen dat in een cultuur waar GM als controversieel werd beschouwd (Oekraïne) het een positief effect had op de beoordeling ervan wanneer de technologie werd gepresenteerd als een middel voor het maken van biobrandstof in plaats van voedsel, wat ook resulteerde in positievere beoordelingen voor genomics. Dit effect ontbrak echter in Nederland waar GM als minder controversieel werd ervaren en gemiddeld als neutraal werd beoordeeld. Een ander gevolg genoemd in de literatuur is dat concepten als meer gelijkend worden beoordeeld wanneer er een hoger risico wordt ervaren. De resultaten van Hoofdstuk 4 lieten echter niet zien dat de oordelen van GM en genomics meer op elkaar leken wanneer er meer risico werd ervaren. Een verklaring hiervoor is dat relatie tussen attitudes van de gebruikte bekende technologie en de onbekende technologie toch al heel erg hoog was. Dit biedt extra ondersteuning voor de gedachte dat de technologieën in dezelfde categorie werden geplaatst op basis van alleen gelijkheid in naam in plaats van specifieke technische eigenschappen (die bij de beoordelaar bekend zouden moeten zijn geweest) die afhankelijke van het ervaren risico gehalte een wisselende rol van belang kunnen spelen.

Het doel van Hoofdstuk 5 was het onderzoeken van de invloed van geactiveerde kennis op de evaluatie van gepresenteerde informatie. Op basis van het idee dat categorisatie de basis kan zijn van leren, zoals gepresenteerd in Hoofdstuk 2, werd verwacht dat de naam van de technologie een belangrijke invloed kan hebben op het leerproces. De categorisatie zou kunnen beïnvloeden welke informatie wordt opgemerkt, maar ook hoe de informatie wordt geïnterpreteerd en geëvalueerd. De resultaten toonden dat wanneer informatie over genomics werd gepresenteerd de gebruikte naam de belangrijkste voorspeller voor de resulterende evaluatie was; de gepresenteerde informatie had geen betekenisvolle invloed. De resultaten lieten zien dat de gepresenteerde informatie werd geïnterpreteerd met behulp van geactiveerde kennis, in plaats van dat de geactiveerde kennis werd bijgesteld door de gepresenteerde informatie. Dit toont aan dat de invloed van de naam een blijvende invloed kan hebben zelfs wanneer er wel aandacht is voor verdere informatie.

Conclusies

Alle resultaten toonden dat de naam gebruikt om genomics te omschrijven een significante invloed heeft op hoe de technologie werd ervaren en geëvalueerd. Mensen gebruikten geactiveerde associaties om genomics te beoordelen en dit bleek onafhankelijk van of het werd gepresenteerd als een toepassing voor het produceren van voedsel of biobrandstoffen. Het patroon van evaluaties past bij een proces van categorisatie om tot een oordeel te komen. Wanneer een naam categorisatie met GM uitlokt zijn de evaluaties minder positief dan wanneer een naam wordt gebruikt dat stuurt naar categorisatie met traditionele veredeling.

De resultaten lieten zien dat het belangrijk is om goed over een naam van een technologie na te denken. De gekozen naam kan bepalend zijn voor de percepties die ontstaan in de samenleving door de manier waarop mensen het gebruiken om betekenis te geven aan de concepten waar ze mee geconfronteerd worden. In veel gevallen zullen mensen slechts hun associaties hebben wanneer ze keuzes moeten maken. Daarnaast zullen de gevormde associaties bepalen op welke manier informatie wordt geïnterpreteerd wanneer deze wel beschikbaar is. Hoewel dit niet betekent dat percepties nooit kunnen veranderen, zorgt het er wel voor dat het heel moeilijk is om verandering te bereiken. Een zorgvuldig gekozen naam kan een effectief hulpmiddel zijn om het juiste idee snel en efficiënt over te brengen.

Reginald Boersma

Wageningen School of Social Sciences (WASS)

Completed Training and Supervision Plan

Name of the learning activity	Department/Institute	Year	ECTS*
A) Project related competences			
Lunch Seminars on Consumer Behaviour	MCB	2009	1
Cognitive Issues in Survey Response	WASS	2010	3
Investigating Technology	WASS	2011	4
Motivation and Behaviour in relation to climate change	University of Copenhagen	2011	7,5
Interpretive methods and methodologies: an Introduction	WASS	2013	4
B) General research related competences			
Introduction course	WASS	2009	1,5
Seminars Genomics	META	2010-2012	2
Mansholt Multidisciplinary Seminar	WASS	2012	1
Leesgroep Simondon	META/CTC	2012	1
Scientific Writing	WASS	2013	1,8
'First Impressions of new technologies'	CSG Research days, Berg en Dal, The Netherlands	2009	1
'What can stakeholders involved in genetic manipulation learn from the recent nuclear power debacles'	EFFoST, Berlin, Germany	2011	1
'Pride and Prejudice and Genomics'	CBSG Summit, Wageningen, The Netherlands	2012	1

'The effects of differences between public and expertise knowledge on public communication of science'	PCST, Florence, Italy	2012	1
'Genomics, wat is dat? Gestuurde informatieverwerking door associaties'	Etmaal van de communicatiewetenschap, Leuven, België	2012	1
C) Career related competences/personal development			
ACT Teaching	WUR	2009-2010	2
Teaching assisting social psychology	WUR	2010	2
ACT Cursus voor procesbegeleiders	WASS	2011	1
Total			**36,8**

*One credit according to ECTS is on average equivalent to 28 hours of study load

Acknowledgements

Writing a dissertation is an endeavour impossible to do alone. I have fond memories of people from all over the world that I had the pleasure of meeting during my work and here I will thank everyone as good as I can.

First, I want to thank my present and past advisors Bart Gremmen, Cees van Woerkum, Reint Jan Renes, and Marijn Poortvliet. Cees, as a PhD-student, it was very inspiring to have access to your insights and vast experience. Reint Jan, thank you for your encouragement and enthusiasm in the first part of this project. Marijn, thank you for taking over in the last stretch. You detailed comments were invaluable in finishing this dissertation. I would also like to thank chair holders Peter Feindt and Marcel Verweij for their support and conversations.

I want to take some extra space to thank Bart. Thank you for your trust and freedom. I genuinely enjoyed our talks. Your ability to quickly grasp concepts of psychology and add to them from philosophy made you as inspiring as a promotor can be. Being your PhD-student was both a pleasure and enriching.

I want to give many thanks to my colleagues at META. Paul, I want to thank you for your company and a friendship. It was a pleasure being your roommate. Pieter, I can clearly remember how you made me feel welcome and part of the group after I arrived, thank you. Robert-Jan, I really enjoyed the diners at your place. It made me feel I wasn’t too far from home. Lebeyesus, it was a pleasure to get to know you when we were sharing a room with you at the end. I hope that you are well wherever you are. Douwe, Mario, Karen, and Jacqueline, I really enjoyed your company and also valuable insights during discussion. And last but not least, Josette. My time with META wouldn’t have been the same without you and I think it is nothing short of fantastic how you always took care of everyone.

Arnout Fischer and Erica van Herpen, at the beginning of my research I had the great fortune of being part of your seminars. Not only did those shape my thinking in an important way, you also have greatly influenced my dissertation by working in the lab together, during courses and pointing me to helpful literature. Thank you both.

I would also like to thank all the people at the secretary of CPT. I especially want to thank Sylvia for her support during the project. Also, a very big thank you to Inge. Your help at the end was really indispensable.

Freddy Woudstra, thank you for being a great friend ever since the day you choose me to be your new housemate. The stage wouldn't have been complete without you on it. Robert-Jan, it gives me great comfort knowing that you are here to help.

With Wageningen being in the middle of public-transport-nowhere, I couldn't have made it without places to stay when necessary. Jette and Pauline, thank you for taking me in and making me feel comfortable and welcome.

Finishing this dissertation would have been impossible without Joyce Meijering. Thank you for always being able to watch over FelineF5, I don't see how I could ever have finished without it.

Even though their efforts might not have been directly related to this dissertation, some have made a difference during the period I was working on the project in such a way that these acknowledgements would not feel complete without them. Thank you Niels Smit Duyzentkunst, my parents, René and Carolien Boersma, Hans Cornelis, Helga Venema, Hinke Groothof, Nienke Venema, Noelle Aarts, Hanneke Nijland, Edwin Oberjé, Melissa Navarra and God.

Finally, I wish to thank my family. Kim, I find it very hard to write a thank you for your support during this period in my life. I was planning on writing how special I found it that we started together and how we were able to share our experiences. It is true, but it feels insignificant to what you mean to me. You are always there in everything and I wouldn't be complete without you. We were two and now we are four because of our children, who have the best mother I can image. Feline en Lotta, er is geen enkele manier waarop ik kan beschrijven wat jullie voor mij betekenen. Feline, ik ben zo blij dat ik jou de afgelopen vier jaar heb mogen leren kennen. Jij deed alles wat er al was verbleken met je plezier, je energie en je wijsheid. Lotta, ik ben blij dat je er al bent zodat ik nu over je kan schrijven. Alles wordt mooier met je glimlach en plezier. Ik hoop dat jullie allebei later precies worden wie jullie zijn.

Colophon

The research described in this thesis was funded by the Centre for BioSystems Genomics and the CSG Centre for Society and the Life Sciences.

Financial support from Wageningen University & Research for printing this thesis is gratefully acknowledged.

Reginald.Boersma@gmail.com